

**INSTALLATION RESTORATION
PROGRAM (IRP) ADDENDUM SITE
INVESTIGATION REPORT
FOR IRP SITE NO.1**

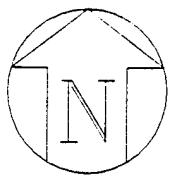
VOLUME I

**101st AIR CONTROL SQUADRON AND
MASSACHUSETTS AIR NATIONAL GUARD
WORCESTER AIR NATIONAL GUARD STATION
WORCESTER, MASSACHUSETTS**

FEBRUARY 1996



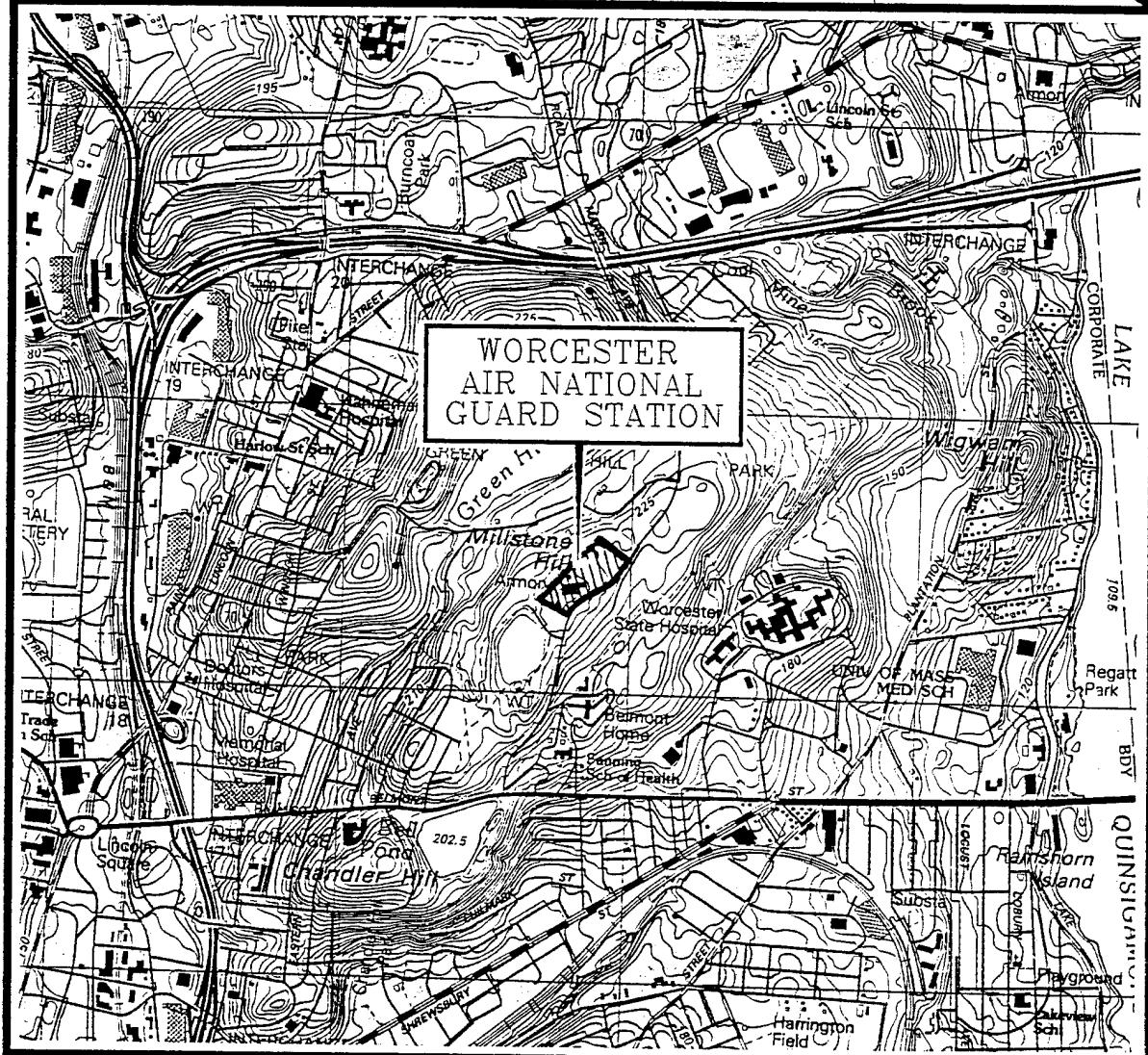
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JANUARY 1998

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VOLUME I

**101st AIR CONTROL SQUADRON AND
MASSACHUSETTS AIR NATIONAL GUARD
WORCESTER AIR NATIONAL GUARD STATION
WORCESTER, MASSACHUSETTS**

FEBRUARY 1996

Prepared For

**HQ ANG/CEVR
ANDREWS AFB, MARYLAND**

Prepared By

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Addendum Site Investigation Report
101st ACS, Worcester ANGS
Worcester, Massachusetts

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LIST OF ACRONYMS

ACS	Air Control Squadron
Addendum Site	Addendum Area of IRP Site No. 7
AGE	Aerospace Ground Equipment
AMDL	Analytical Method Detection Limits
ANG	Air National Guard
HQ ANG/CEVR	Headquarters Air National Guard/Installation Restoration Branch
ANGS	Air National Guard Station
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing and Materials
ATHA	Ambient Temperature Headspace Analysis
BH	Borehole
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
°C	Degrees Centigrade
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeters per second
CMR	Commonwealth of Massachusetts Regulation
CRDL	Contract Required Detection Limit
DD	Decision Document
DERP	Defense Environmental Restoration Program
DL	Detection Limit
DoD	Department of Defense
DQO	Data Quality Objective
DRMO	Defense Reutilization and Marketing Office
EIS	Engineering Installation Squadron
EO	Executive Order
°F	Degrees Fahrenheit
FS	Feasibility Study
Ft	Feet
GC	Gas Chromatograph
gpm	gallons per minute
HAS	Hazard Assessment Score
HRS	Hazard Ranking System
HSA	Hollow-stem auger
ID	Inside Diameter
IDL	Instrument Detection Limit
IRP	Installation Restoration Program
JP-4	jet fuel #4
JP-5	jet fuel #5
LTM	Long-term monitoring
MADEP	Massachusetts Department of Environmental Protection
MA ANG	Massachusetts Air National Guard
MCP	Massachusetts Contingency Plan

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LIST OF ACRONYMS (Concluded)

MCP/RCS	Massachusetts Contingency Plan/Reportable Concentrations
MEK	Methyl ethyl ketone
$\mu\text{g}/\text{kg}$	micrograms per kilogram
mg/kg	milligrams per kilogram
ml	milliliter
MOGAS	Motor gasoline
MS	Matrix Spike
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NEI	NyTest Environmental, Inc.
OpTech	Operational Technologies Corporation
OWS	Oil/Water Separator
PA	Preliminary Assessment
PCB	Polychlorinated biphenyl
PID	Photoionization Detector
ppm	parts per million
ppb	parts per billion
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
SI	Site Investigation
SVOC	Semivolatile Organic Compound
TDS	Technical Drilling Services, Inc.
TPH	Total Petroleum Hydrocarbons
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

ES 1.0 INTRODUCTION

An Addendum Site Investigation (SI) was conducted at the extended area of Installation Restoration Program (IRP) Site No. 1 – (Old Embankment/Vicinity of the Old Waste Holding Area), located at the 101st Air Control Squadron (ACS) and the 212th Engineering Installation Squadron (EIS), Worcester Air National Guard Station (ANGS), Worcester, Massachusetts. Headquarters Air National Guard/Installation Restoration Branch (HQ ANG/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare an Addendum Site Investigation (SI) Work Plan and conduct the Addendum SI at the expanded area of IRP Site No. 1 (Addendum Site) to determine the relationship between a dry well discovered north of Building 001 and contamination detected at the site during the initial SI. This investigation was conducted as outlined in the Addendum SI Work Plan submitted to the HQ ANG/CEVR in November 1994, and approved in February 1995. The field investigation conducted by OpTech at the 101st ACS began on 4 April 1995 and was completed on 6 April 1995.

ES 2.0 PREVIOUS INVESTIGATIONS

A Preliminary Assessment (PA) of the 101st ACS and 212th EIS, Worcester ANGS, was conducted by Science & Technology, Inc., in May 1990 and published in February 1991. Information obtained through interviews, review of Station records, and field observations resulted in the identification of one potentially contaminated disposal and/or spill site. This site was identified as IRP Site No. 1 (Old Embankment/Vicinity of the Old Waste Holding Area).

The SI of IRP Site No. 1, as identified in the PA, was conducted by OpTech. The SI field investigation began on 15 November 1993 and was completed on 19 November 1993. SI findings indicated semivolatile organic compounds (SVOCs), metals, and total petroleum hydrocarbons (TPH) detected above Massachusetts Contingency Plan Reportable Concentrations (MCP/RCs) in several soil samples submitted for analysis. SVOCs exceeding MCP/RCs were detected at borings 01-003BH, 01-005BH, and 01-008BH. Metals exceeding MCP/RCs were detected at borings 01-001BH through 01-006BH, 01-008BH, 01-009BH, and 01-015BH. TPH contamination exceeding MCP/RCs was detected at borings 01-008BH and 01-012BH. The source and extent of SVOC, metal, and TPH contamination was not determined during the SI. Isoconcentration maps of the contamination indicated a possible source of contamination south

of the IRP site boundary. The SI Final Report, completed in February 1995, outlines complete investigative findings from the initial SI conducted at IRP Site No. 1.

In 1993, as part of a nationwide Air National Guard (ANG) program, five underground storage tanks (USTs) and two oil/water separators (OWS) at the Station were removed under the direction of Wadleigh Environmental of Boston, Massachusetts. During removal of the USTs, contamination was detected and confirmed by laboratory analysis around a 10,000-gallon fuel oil UST north of Building 001. Two OWS located near Buildings 001 and 002 were also removed. During removal of the OWS north of Building 001, the OWS was discovered to be a concrete-lined dry well. Floor drains in the vehicle maintenance shop in Building 001 were connected to this dry well. Recently, the floor drains were re-routed to the OWS adjacent to Building 002. The dry well and surrounding soil were removed and replaced with clean fill material. No laboratory analysis was conducted on soil from the excavated area and, once the hole was filled, it was covered flush with asphalt similar to the surrounding asphalt surface.

Since SI results indicated the source of contamination was located south of the IRP site boundary, and with the discovery of the dry well, additional investigation was required to characterize the source and extent of contamination at the site. Therefore, the HQ ANG/CEVR authorized additional work to determine the relationship between this potential release source and the contamination detected during the initial SI.

ES 3.0 IRP SITE NO. 1

The southern boundary of the initial IRP Site No. 1 area extended from the northeast corner of Building 003 (Storage Building) to the northwest corner of Building 002 Aerospace Ground Equipment (AGE) Shop. The site extends to the north approximately 30 feet beyond the northwest perimeter fence. The north boundary of the site parallels the fence line. The Old Embankment extended from the northwest corner of Building 002 to the northeast corner of Building 003 until the early 1980s, at which time the low area located between the embankment and current fence line was filled in with construction debris. The site extends to the base of the current embankment, which parallels the northern fence line. A portion of the site lying outside of the fence line has been extended approximately 40 feet to the southwest to include a portion of the current embankment.

The Addendum Site is an extension of the original boundaries of IRP Site No. 1 to determine the relationship between the former dry well located north of Building 001 and IRP Site No. 1 as defined above. The Addendum Site extends the original boundaries of IRP Site No. 1

southward approximately 75 feet. The west boundary of the site begins at the northeast corner of Building 003 and extends south along the east wall of Building 003 and intersects the north wall of Building 001. The south edge of the site extends east along the north wall of Building 001 to its northeast corner. The east edge of the site extends from the northeast corner of Building 001 to the southwest corner of Building 002.

ES 3.1 INVESTIGATIVE FINDINGS

Thirteen soil samples were collected from the Addendum area of IRP Site No. 1 and submitted for laboratory analysis to confirm the presence or absence of contamination, and to provide data needed to determine the relationship between a former dry well located north of Building 001 and contamination detected during the initial SI. Potential contaminants from the former dry well consisted of waste oil, organic solvents, and fuels. Therefore, samples were submitted for analysis of volatile organic compounds (VOCs), SVOCs, and TPH. To remain consistent with the analytical program during the initial SI, samples were also analyzed for polychlorinated biphenyls (PCBs) and priority pollutant metals. One additional soil sample was collected from a background location to assess naturally-occurring concentration levels, and contaminant or chemical concentrations already existing in the area due to general environmental conditions.

Laboratory results indicated low concentrations of VOCs and estimated concentrations below sample quantitation limits of PCBs in several soil samples at the Addendum Site. VOCs and PCBs were not detected above MCP/RCs in any sample at the Addendum Site. SVOCs were detected in 5 of the 14 soil samples submitted for laboratory analysis. Two soil samples contained SVOCs exceeding MCP/RCs; a soil sample from boring 01-018BH and 01-019BH contained benzo(a)anthracene and chrysene in excess of MCP/RCs. Additionally, the sample from 01-019BH also contained benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene at concentrations in excess of MCP/RCs. TPH were detected in varying concentrations from all 15 soil samples submitted for analysis, however, only one sample from 01-018BH contained TPH exceeding of MCP/RCs. Fourteen soil samples were submitted for priority pollutant metals analysis. Eight samples contained one target metal at concentrations exceeding MCP/RCs. Arsenic was detected in seven samples from borings 01-017BH, 01-019BH, 01-020BH, 01-021BH, and 01-023BH at concentrations exceeding its MCP/RC. Beryllium was detected in one sample from boring 01-016BH at concentrations exceeding its MCP/RC.

ES 4.0 CONCLUSIONS

Based on results obtained from the Addendum SI, no relationship can be established between the former dry well located north of Building 001 and contamination detected during the initial SI at IRP Site No. 1. SVOC and TPH contamination detected does not indicate the former dry well location as a source of contamination as seen in borings 01-003BH, 01-005BH, 01-012BH, 01-018BH, and 01-019BH.

Analytical results from the initial and Addendum SI indicate the probable source of SVOC and TPH contamination at IRP Site No. 1 is a 12,000-gallon JP-5 UST, a 275-gallon JP-5 UST, and the piping system that services them. The USTs and associated piping are currently in use at the Station. Although arsenic and beryllium were detected at the Addendum Site, these metals are naturally-occurring and are not components of the potential contamination identified with the IRP site. The highest levels detected during the Addendum SI (59.4 mg/kg arsenic and 0.88 mg/kg beryllium) are near the highest background concentrations obtained during the initial SI (67.0 mg/kg arsenic and 0.3 mg/kg beryllium).

ES 5.0 RECOMMENDATIONS

Based on the analytical results of the Addendum SI, no further investigative action is recommended under the IRP. The following recommendation is presented:

- Further investigate the area surrounding the active USTs as part of the RCRA Subtitle I and Massachusetts UST compliance programs.

SECTION 1.0 INTRODUCTION

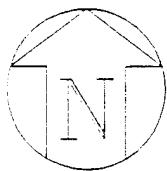
This Addendum to the Site Investigation (SI) Report for Installation Restoration Program (IRP) Site No. 1 Old Embankment (Vicinity of the Old Waste Oil Holding Area) presents the results of additional investigation activities conducted at the 101st Air Control Squadron (ACS) and the 212th Engineering Installation Squadron (EIS), Worcester Air National Guard Station (ANGS), Worcester, Massachusetts (Figure 1.1).

Headquarters Air National Guard/Installation Restoration Branch (HQ ANG/CEVR) authorized Operational Technologies Corporation (OpTech) to prepare an Addendum SI Work Plan and conduct the Addendum SI at the expanded area of IRP Site No. 1 (also referred to as the Addendum Site) to determine the relationship between a dry well discovered north of Building 001 and the IRP site. This investigation was conducted as outlined in the Addendum SI Work Plan submitted to the HQ ANG/CEVR in November 1994, and approved in February 1995.

Baseline data exists for Worcester ANGS from the previous IRP SI; therefore, this Addendum SI Report supplements the Installation Restoration Program (IRP) Site Investigation Report for IRP Site No. 1, 101st Air Control Squadron, Massachusetts Air National Guard, Worcester Air National Guard Station, Worcester, Massachusetts, prepared in January 1995 by OpTech (hereinafter referred to as the *1995 SI Report*).

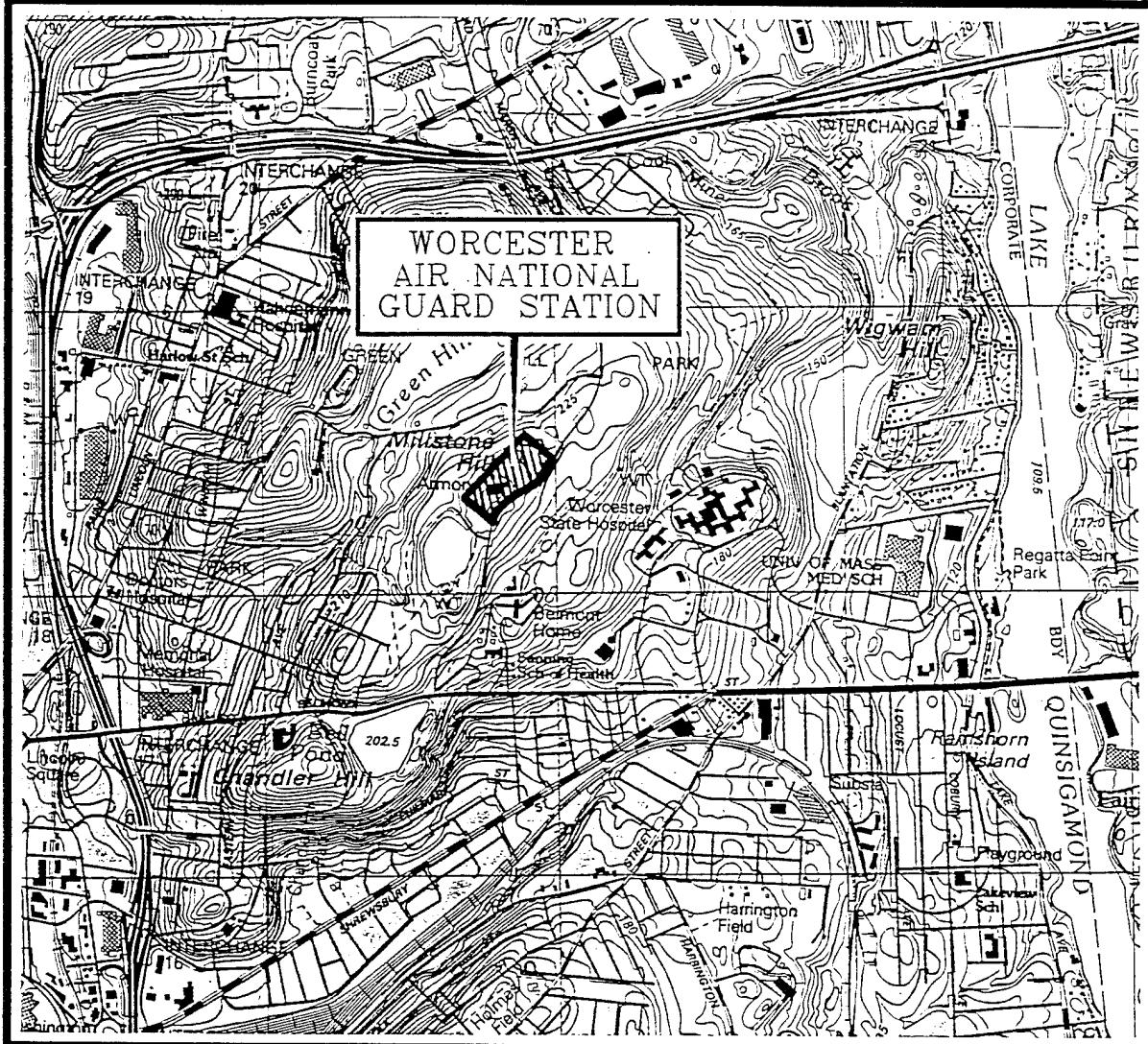
Additional information is contained in the Installation Restoration Program (IRP) Site Investigation Work Plan for IRP Site No. 1, 101st Air Control Squadron and 212th Engineering Installation Squadron, Massachusetts Air National Guard, Worcester Air National Guard Station, Worcester, Massachusetts, prepared in July 1993 by OpTech, and utilized in the initial SI conducted 15 November through 19 November 1993 (herein referred to as the *1993 SI Work Plan*) and in the Installation Restoration Program (IRP) Addendum Site Investigation Work Plan for IRP Site No. 1, 101st Air Control Squadron and 212th Engineering Installation Squadron, Massachusetts Air National Guard, Worcester Air National Guard Station, Worcester, Massachusetts, prepared in February 1995 by OpTech, and utilized in the Addendum SI conducted 3 April through 6 April 1995 (herein referred to as the *1995 Addendum SI Work Plan*).

To avoid extensive informational redundancy within this Addendum Report, references will be made to the baseline information contained in the three aforementioned documents. This Report



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FIGURE 1.1

STATE LOCATION MAP OF WORCESTER
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presents investigative findings from the Addendum SI and is intended to supplement, not supersede, the *1995 SI Report*.

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SECTION 2.0 BACKGROUND INFORMATION

2.1 FACILITY DESCRIPTION

Worcester ANGS is located atop Millstone Hill just south of Green Hill Pond within the City and County of Worcester, Massachusetts. The Station occupies approximately seven acres of land along Skyline Drive north of State Route 9 and has three permanent buildings (Figure 2.1). Building 001 is the main facility (Headquarters), which houses both the 101st ACS and the 212th EIS and each of their vehicle maintenance operations. Building 002 is the Aerospace Ground Equipment (AGE) Shop, and Building 003 is the 212th EIS storage facility.

Worcester ANGS has a normal approximate working population of 63 people. The Station serves as a site for unit training assemblies which meet one weekend per month. During this weekend, the Station population reaches approximately 433.

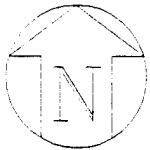
The organizational history of the 101st ACS and the 212th EIS, the historic installation waste disposal practices, and the information on the Preliminary Assessment (PA) conducted at the Station, are included in the *1995 SI Report*.

2.1.1 Adjacent Land Use

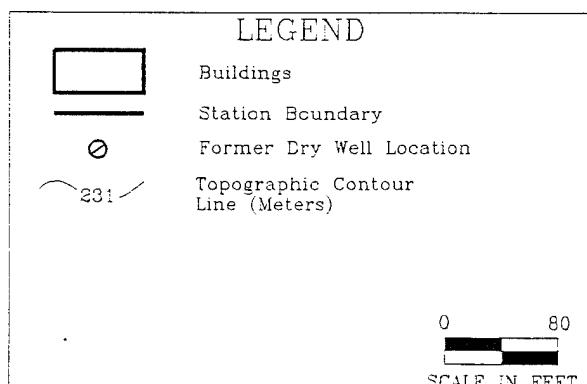
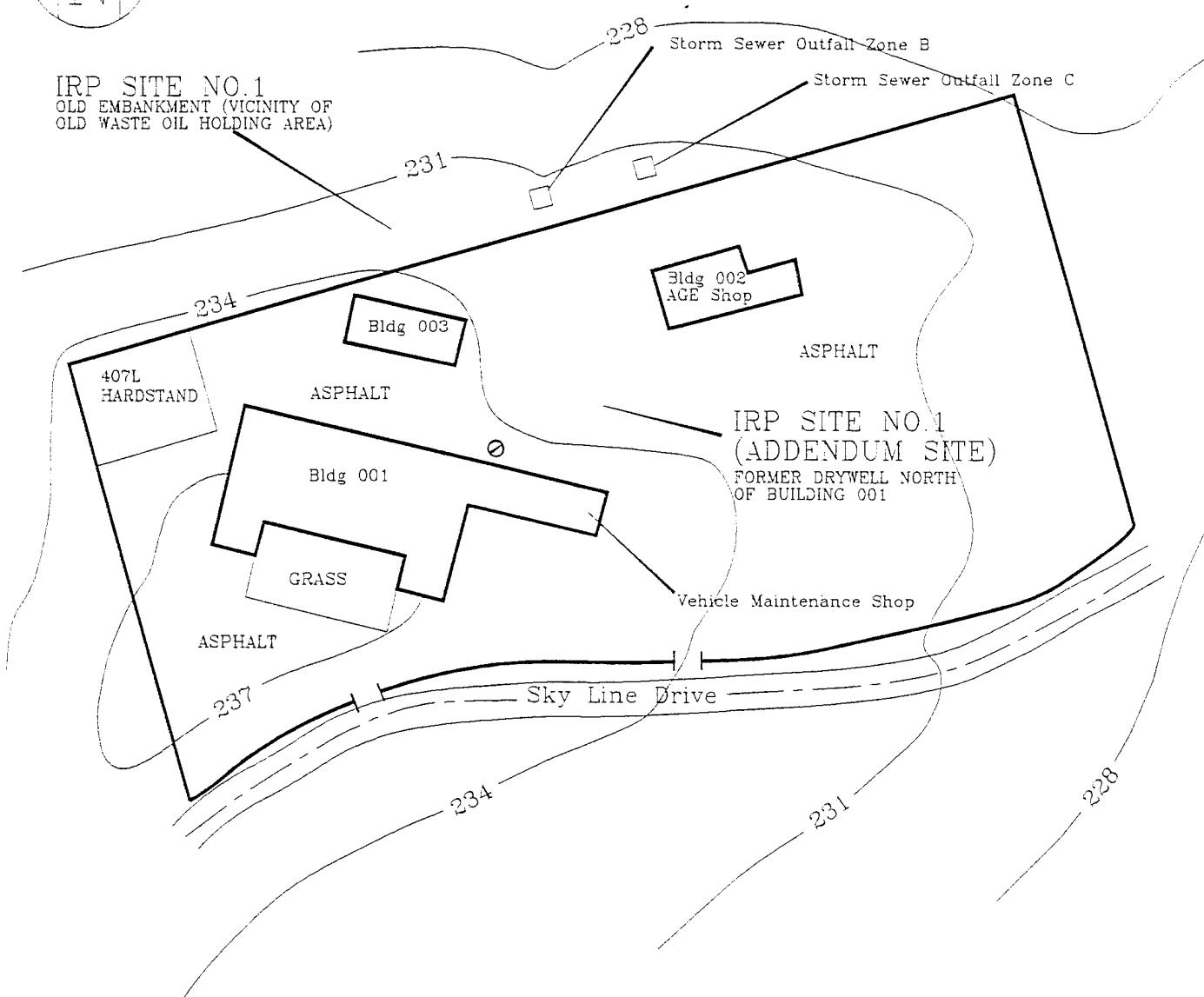
The Station is located on top of Millstone Hill and is completely surrounded by city park land. The municipal park includes a golf course located approximately 1,000 feet north of the Station, ponds and recreational areas to the northwest and west, and undeveloped woodlands to the southwest, northeast, and east. The Worcester State Hospital is located approximately 1,500 feet east of the Station. The Belmont Home and Fanning School of Health are located approximately 1,000 feet south of the Station. Developed residential and small business areas are located from 1,500 feet to 3,500 feet to the west, north, and south of the Station (see Figure 2.2).

2.1.2 Waste Disposal Practices

Mission support activities required the storage, use, and disposal of hazardous materials such as oils, hydraulic fluids, solvents, and fuels (diesel, motor gas (MOGAS), JP-4, and JP-5). The largest use of these materials, and consequently the largest generator of waste, is for vehicle and AGE maintenance. Waste disposal practices for the Worcester ANGS are fully outlined in the *1995 SI Report*.



IRP SITE NO. 1
OLD EMBANKMENT (VICINITY OF
OLD WASTE OIL HOLDING AREA)



SOURCE: Worcester ANG Station, Worcester, Massachusetts, ANG Development Plan, 1969.

FIGURE 2.1

WORCESTER\WORC1-21

WORCESTER AIR NATIONAL GUARD STATION
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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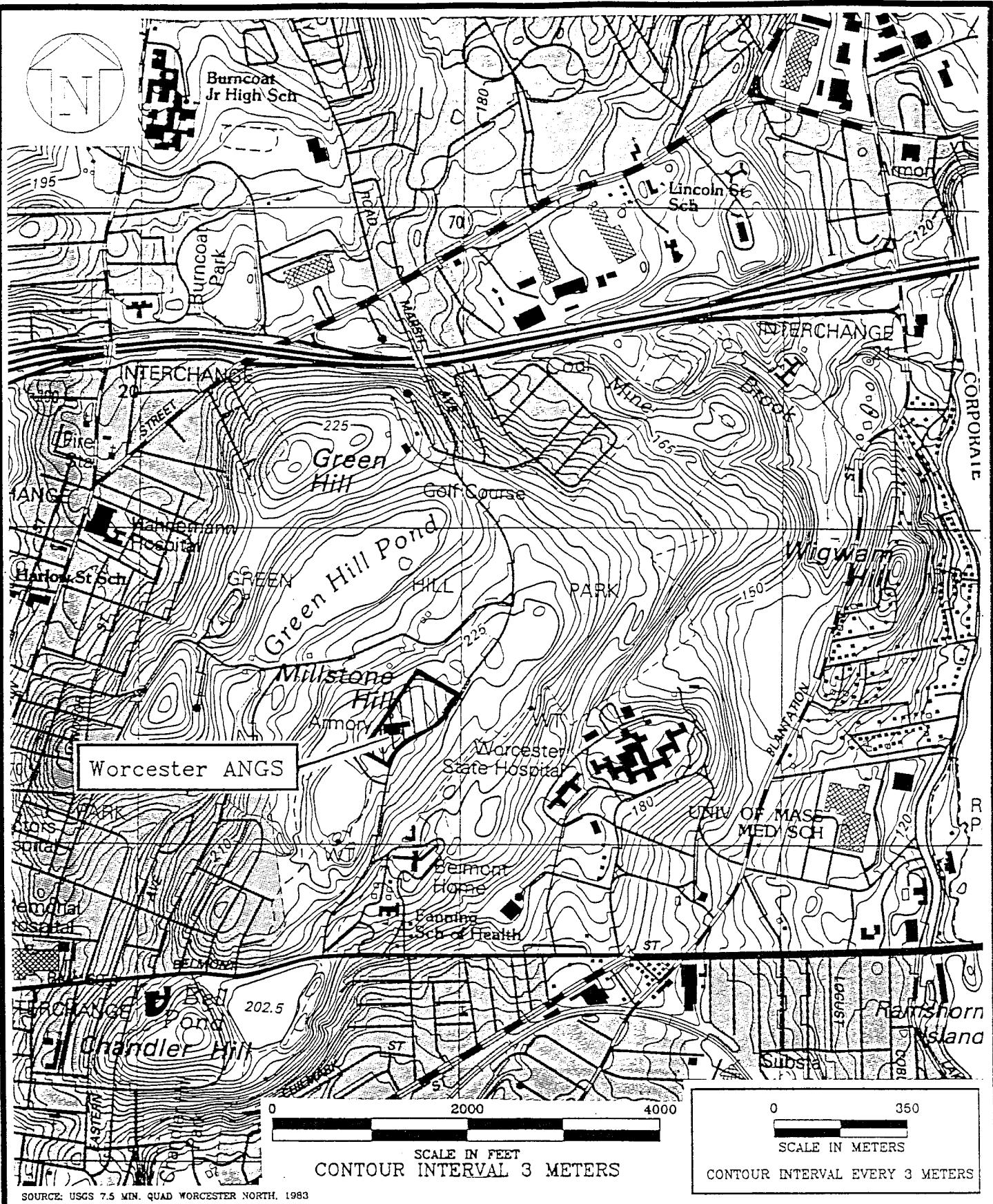


FIGURE 2.2

LOCATION MAP

Worcester Air National Guard Station
Worcester, Massachusetts

WORCESTER\WORC4-IL

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2.2 IRP SITE NO. 1 BACKGROUND INFORMATION

The site history and potential release sources for the initial area of IRP Site No.1 were discussed in the *1995 SI Report*.

2.2.1 Addendum Site History

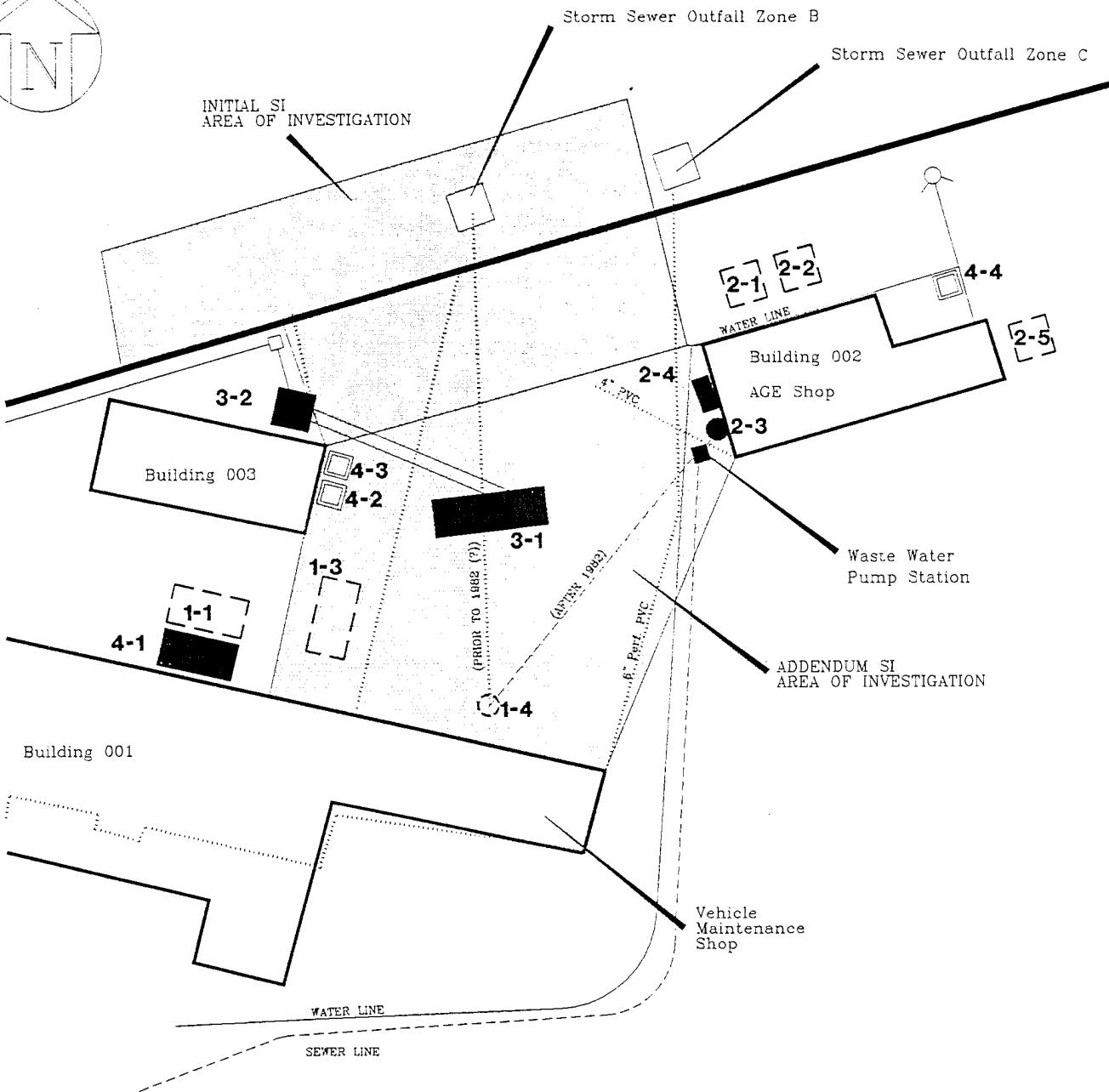
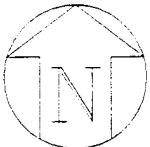
In 1993, as part of a nationwide Air National Guard (ANG) program, five underground storage tanks (USTs) and two oil/water separators (OWS) at the Station were removed under the direction of Wadleigh Environmental of Boston, Massachusetts. During this program, three replacement tanks and one OWS were installed. Figure 2.3 shows the locations of removed and existing USTs. During removal of the USTs, contamination was detected and confirmed by soil sample laboratory analysis in the area of a 8,000-gallon fuel oil UST (tank #1-1) located north of Building 001. Additionally, two OWS located near Buildings 001 and 002 (Vehicle Maintenance and AGE Buildings, respectively) were also removed; the OWS adjacent to Building 002 (tank #2-3) was replaced with a new OWS system.

During removal of the OWS north of Building 001 (tank #1-4), it was discovered that the OWS was actually a concrete-lined dry well with a gravel bottom. The dry well and surrounding soil were removed and replaced with clean fill material. No laboratory analysis was performed on soil from the excavated area. Upon completion, the area was backfilled and re-surfaced with asphalt.

2.2.2 Addendum Site Potential Release Sources

As outlined in the *1995 SI Report*, prior to 1982 the OWS (tank #1-4) was connected to floor drains in the vehicle maintenance shop in Building 001 that discharged to Storm Sewer Outfall Zone B. After 1982, the floor drains were re-routed to discharge to the OWS adjacent to Building 002. Waste oil was reportedly poured directly into the floor drains at the vehicle maintenance shop on the assumption that it would be captured by the OWS. Other potential contaminants associated with vehicle maintenance activities include organic solvents and fuels (diesel, MOGAS, JP-4, and JP-5). These potential contaminants may have infiltrated through the gravel bottom and, prior to 1982, may have been discharged to the storm sewer outfall outside the perimeter fence.

Based on the information obtained during the initial SI, the dry well was determined to be a possible source of total petroleum hydrocarbon (TPH) and semivolatile organic compound (SVOC)



UNDERGROUND TANK IDENTIFICATION #	CAPACITY (GALLONS)	PRODUCT	YEAR INSTALLED
2-3	400	O/W SEPARATOR	1993
2-4	150	JP-5	1981
3-2	275	JP-5	1976
4-1	8,000	#2 FUEL OIL	1993
4-2 (AST)	5,000	GASOLINE	1993
4-3 (AST)	5,000	DIESEL FUEL	1993
4-4 (AST)	2,000	#2 FUEL OIL	1993

LEGEND

- Buildings
 - Storm Drain
 - Site No.1 Initial SI
 - Site No.1 Addendum SI
 - Location of Removed UST
 - Station Boundary
 - Underground Tank
 - Oil/Water Separator
 - Water Line
 - Sewer Line
 - Above Ground Storage Tank
 - Location of Removed OWS
- 0 80
SCALE IN FEET

SOURCE: PENNY ENGINEERING, INC., SITE PLAN, 1994.

FIGURE 2.3

WORCESTER\WORC-199\UST-OWS

STORAGE TANKS AND OIL/WATER SEPARATORS AT WORCESTER AIR NATIONAL GUARD STATION
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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contamination detected at IRP Site No. 1 and the storm sewer outfall outside the perimeter fence. The *1995 SI Report* presents the complete analytical findings of SI activities conducted at the initial IRP Site No. 1. In summary, benzo(a)pyrene, benzo(b)fluoranthene, 2-methylnaphthalene, and TPH were detected at IRP Site No. 1 at concentrations in excess of the Massachusetts Contingency Plan Reportable Concentrations (MCP/RCs) from the Massachusetts Contingency Plan (MCP), 310 CMR 40.0975. Pyrene and TPH contamination concentrations were presented in the *1995 SI Report* and are presented here as Figure 2.4 and Figure 2.5, respectively. The contaminant concentrations indicate a possible source of contamination south of the site boundary. With the discovery of the dry well, additional investigation was required to characterize the site. Therefore, the HQ ANG/CEVR authorized additional work to determine the relationship between this potential release source and the contamination detected during the initial SI.

2.3 IRP SITE NO. 1 DESCRIPTION

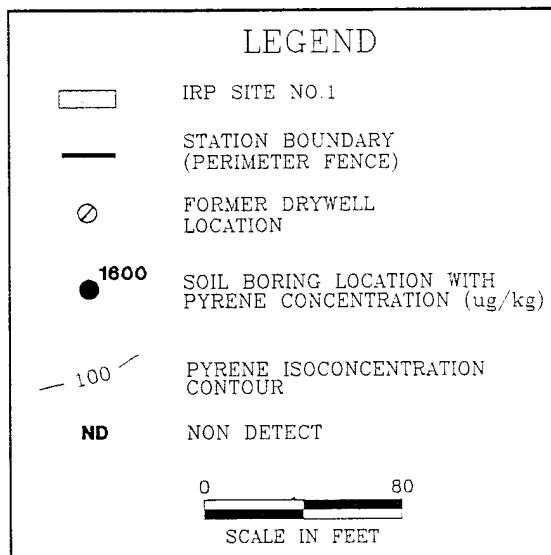
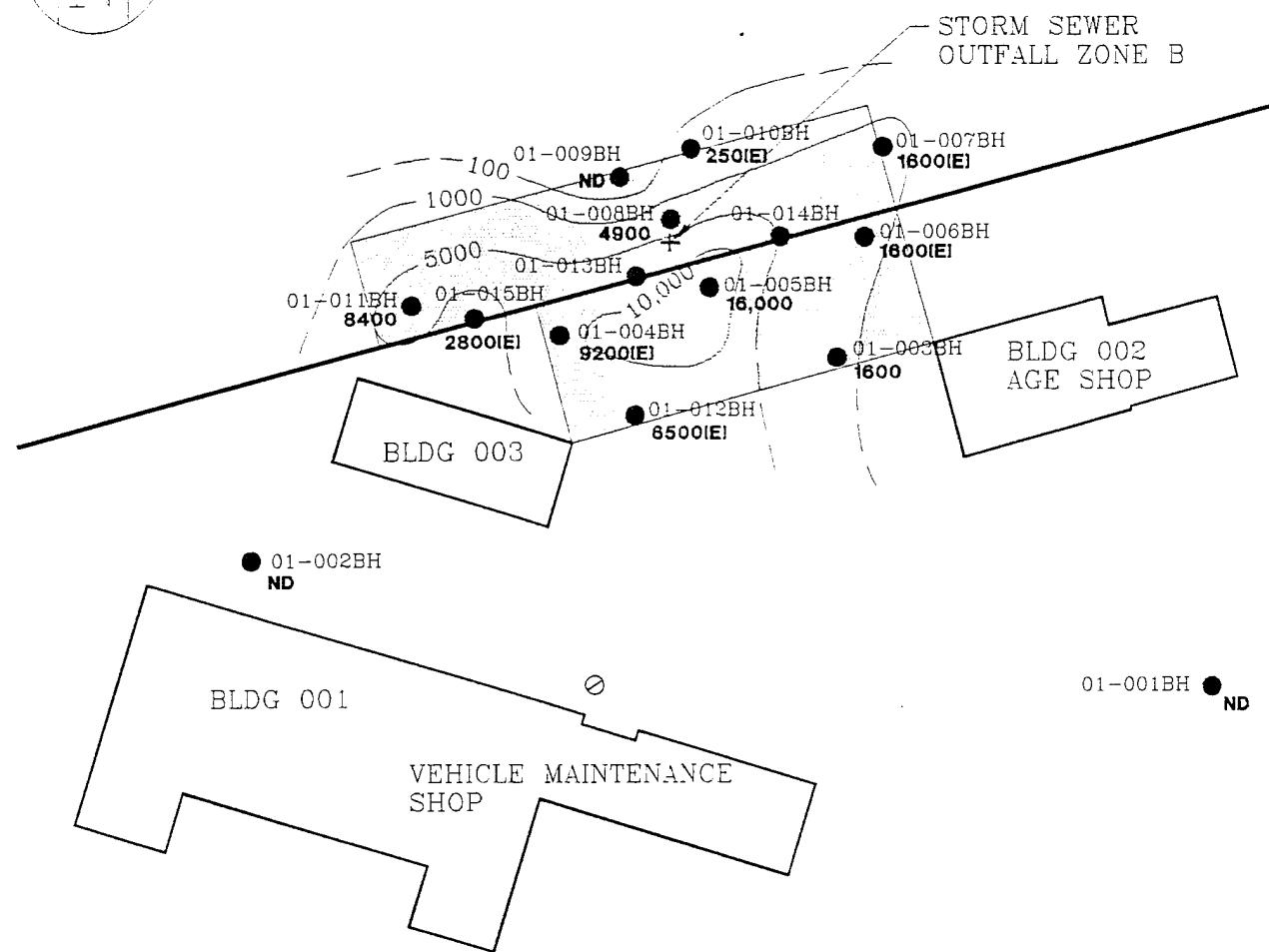
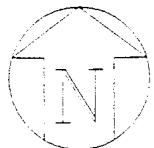
2.3.1 IRP Site No. 1 – Old Embankment (Vicinity of Old Waste Oil Holding Area)

The southern boundary of the site extends from the northeast corner of Building 003 (Storage Building) to the northwest corner of Building 002 (AGE Shop). The site extends to the north approximately 30 feet beyond the northwest perimeter fence. The north boundary of the site parallels the fence line. The Old Embankment extended from the northwest corner of Building 002 to the northeast corner of Building 003 until the 1970s and early 1980s, at which time the low area located between the embankment and current fence line was filled in with construction debris. The site extends to the base of the current embankment, which parallels the northern fence line. The location of IRP Site No. 1 is shown on Figure 2.6.

2.3.2 IRP Site No. 1 – Addendum Site

The Addendum Site is an extension of the original boundaries of IRP Site No. 1 and has been included to determine the relationship between the former dry well located north of Building 001 and IRP Site No. 1 as defined above.

The Addendum Site extends the original boundaries of IRP Site No. 1 southward approximately 75 feet. The west boundary of the site begins at the northeast corner of Building 003 and



SOURCE: TAUPER SURVEY, 1993. MODIFIED BY OPTECH, 1995.

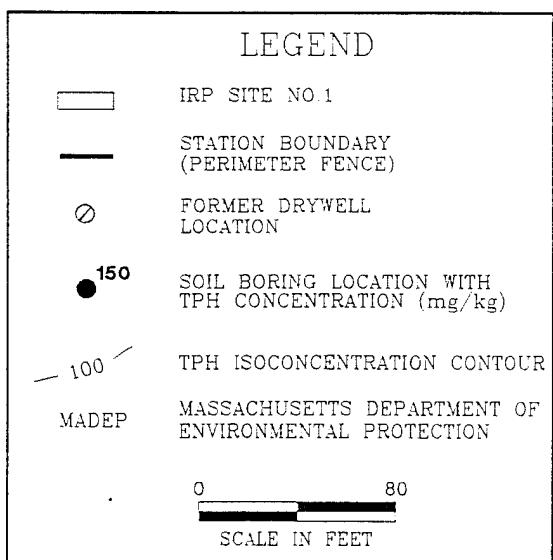
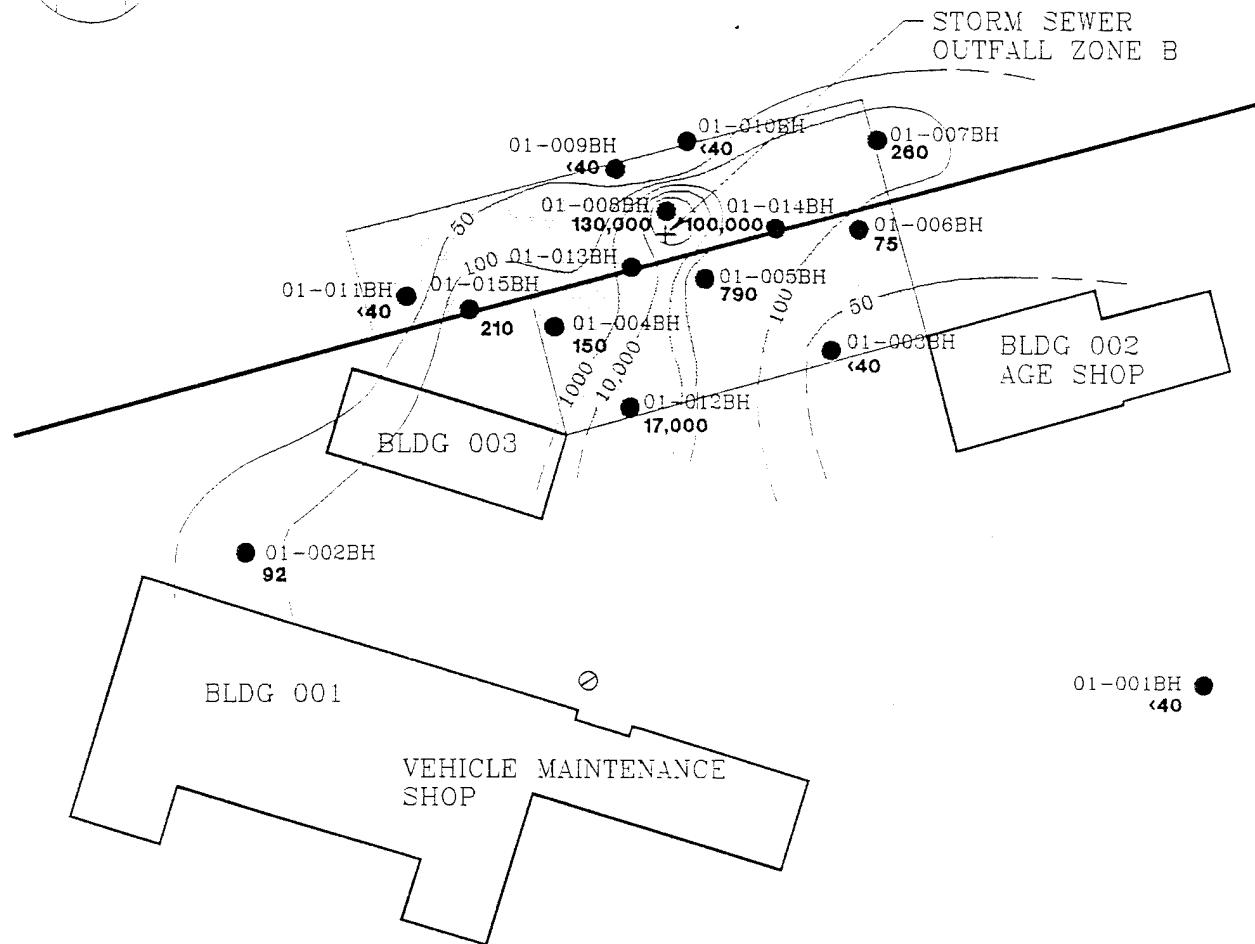
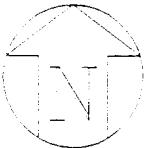
FIGURE 2.4

WORCESTR\CONTOURS

HIGHEST PYRENE (SVOC)
CONTAMINATION PER BOREHOLE
DETECTED DURING THE INITIAL SI
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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NOTE:
MADEP REPORTABLE CONCENTRATION
FOR TPH IS 2,500 mg/kg.

SOURCE: TAUPER SURVEY, 1983, MODIFIED BY OPTECH, 1995.

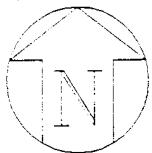
FIGURE 2.5

WORCESTR\CONTOURS

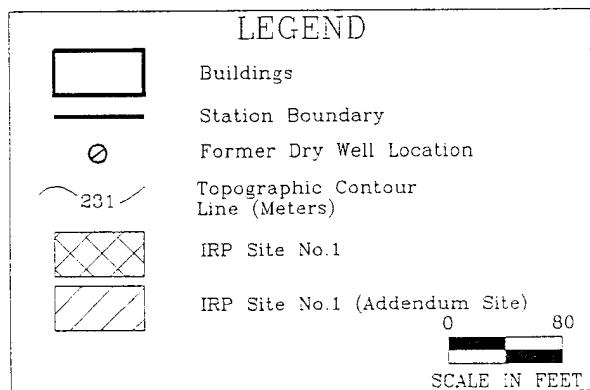
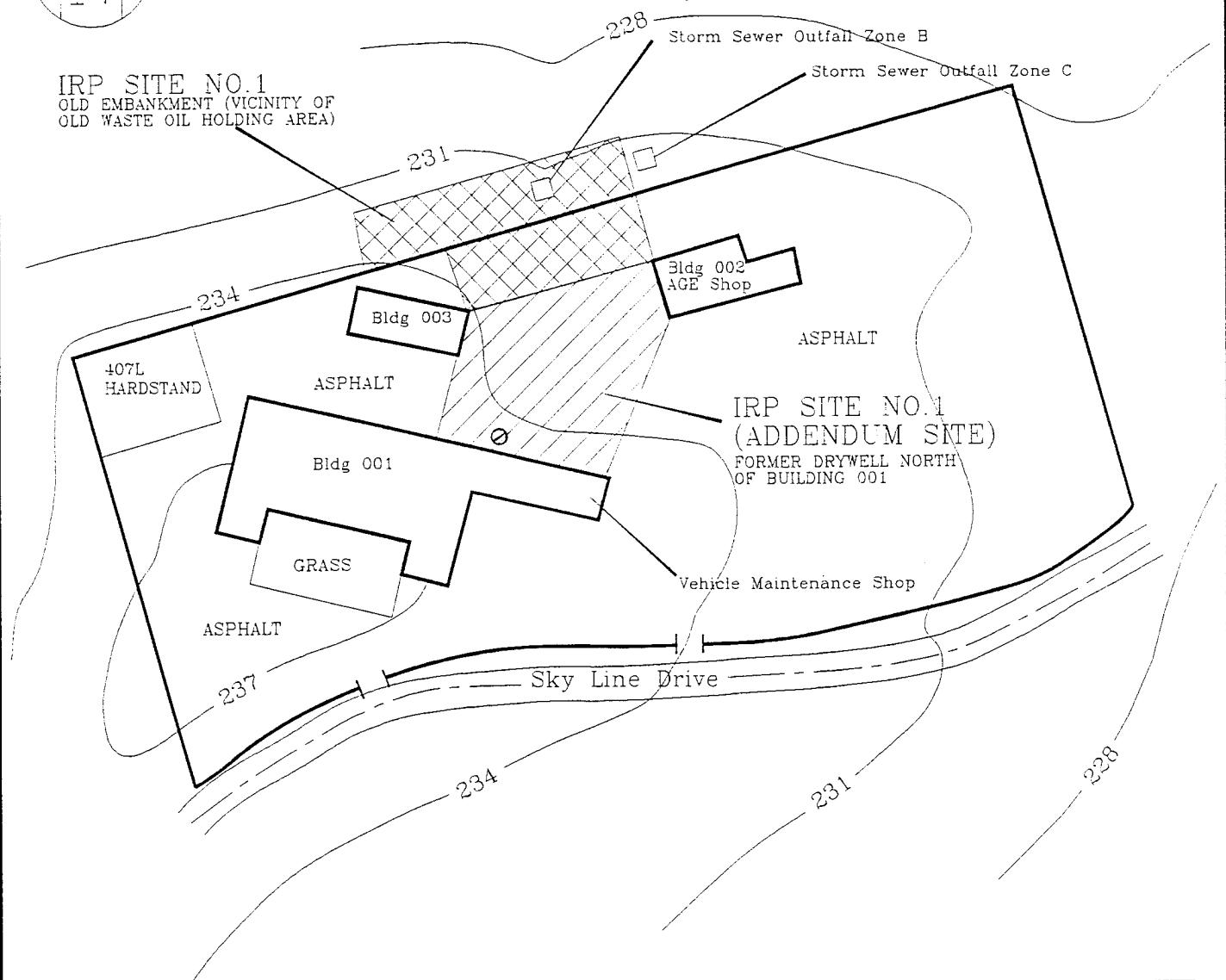
HIGHEST TPH
CONTAMINATION PER BOREHOLE
DETECTED DURING THE INITIAL SI
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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IRP SITE NO.1
OLD EMBANKMENT (VICINITY OF
OLD WASTE OIL HOLDING AREA)



SOURCE: Worcester ANG Station, Worcester, Massachusetts, ANG Development Plan, 1989.

FIGURE 2.6

WORCESTER\WORC1-2I

IRP SITE NO.1 AT
WORCESTER AIR NATIONAL GUARD STATION
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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extends south along the east wall of Building 003 and intersects the north wall of Building 001. The south edge of the site extends east along the north wall of Building 001 to the building's northeast corner. The east edge of the site extends from the northeast corner of Building 001 to the southwest corner of Building 002 as shown on Figure 2.6.

SECTION 3.0 ENVIRONMENTAL SETTING

3.1 PHYSIOGRAPHY

Massachusetts is divided into the New England and Coastal Plain physiographic provinces. The southeastern peninsula and outer islands of Massachusetts are included in the Coastal Plain province while the remainder of the State exists in the New England province. The New England province is further subdivided into sections. The Station is located in the east-central section, termed the New England Upland. This region is characterized by moderately high relief determined by the distribution and resistance of bedrock in relation to pre-glacial and glacial erosion (OpTech, 1993).

3.2 CLIMATE

The climate in the area of Worcester ANGS is characterized by cold winters and moderate summers with occasional hot spells. Precipitation is evenly distributed throughout the year. The total average annual precipitation, based on a 27-year record (1951-1978), is 45.59 inches, and ranges from an average monthly high of 4.49 inches in November to an average monthly low of 3.36 inches in July. Thunderstorms occur on an average of 21 days a year, and an average of 22 days a year have at least one inch of snow on the ground. The average annual temperature for the 27-year reporting period was 48.0° F (Fahrenheit), and the average monthly temperature ranged from 71.9° F in July to 24.0° F in January. Prevailing wind direction is from the west. Average windspeed is highest in the winter at approximately 14 miles per hour.

3.3 GEOLOGY

The geology and landforms of the central Massachusetts area are characterized by glacial topography with moderate to moderately high relief determined by resistant bedrock and glacial erosion. Topographic elevations increase from the easterly river valley lowlands towards the maturely dissected plateau to the west (Stone, 1980). Surface elevations range from 350 to 780 feet (107 to 238 meters) above mean sea level (MSL) in the immediate vicinity of Worcester ANGS. The Station is located along a subdued escarpment which is oriented in a north to south direction. Specifically, the Station is located on the top of a bedrock knob named Millstone Hill, where the surface elevation is approximately 750 to 780 feet (229 to 238 meters) above MSL.

The bedrock underlying the Station is mapped by Emerson, 1917, as being the Lower Cambrian age Ayer Granite. The Ayer Granite has since been named the Ayer Intrusion Complex which

consists of several members. Mapping by Barosh in 1977 indicates the Station is underlain by the Millstone Hill Granite Member. It is described as a light gray, medium-grained, equigranular, nonfoliated granite to granodiorite that weathers light buff to rusty on outcrop. The structural grain of the bedrock in the area is to the northeast, and the dominant structural features are thrust faults and perpendicular normal faults. Several thrust faults are mapped as occurring in the immediate vicinity of the Station. The large amount of faulting probably has fractured the bedrock to a significant degree at the Station location. In his examination of the Ayer Granite on Millstone Hill, Emerson, 1917, reported observing master vertical joints and minor irregular sets of joints that suggested significant fracturing of the bedrock. Fracturing is important in that it creates secondary porosity and permeability in the bedrock which is otherwise nonpermeable.

The bedrock in the vicinity of the Station is, for the most part, covered by a thin layer of surficial material of varying thickness (Walker and Krejmas, 1986). Surface material is primarily composed of Pleistocene glacial deposits and, to a lesser degree, postglacial Holocene deposits. As a result of the high topographic position of the Station, surface material is composed only of Pleistocene glacial deposits and the corresponding overlying soils.

3.4 SOILS

The soil overlying the glacial till at the Station location is classified as the Chatfield-Hollis-Rock outcrop complex. This soil type is formed in association with glacial till and is characteristic of hills and ridges with many bedrock exposures. The soil unit is irregular in shape and averages approximately 20 acres in areal extent. The complex is composed of moderately deep Chatfield soils (45%), shallow Hollis soils (25%), Rock outcrop (15%), and other soils (15%). The soils are intermingled and cannot be mapped separately. Chatfield soils consist of a fine sandy loam, and the depth to bedrock ranges from 20 to 40 inches. Hollis soils are also composed of a fine sandy loam, but the lower 5 inches of subsoil are a gravelly fine sandy loam. Depth to bedrock ranges from 10 to 20 inches for the Hollis soils. The Chatfield and Hollis soils are considered to be well-drained to somewhat excessively drained soils. Permeability is classified as moderate (0.63 to 2.00 inches per hour or 4.45×10^{-4} to 1.41×10^{-3} cm/sec) or moderately rapid (2.00 to 6.00 inches per hour or 1.41×10^{-3} to 4.24×10^{-3} cm/sec).

3.5 HYDROGEOLOGY

The principal aquifers of the Blackstone River Basin, which include Worcester County, are the sand and gravel deposits of glacial origin and the underlying bedrock (Walker and Krejmas, 1986). The glacial sand and gravel aquifer is of primary importance because of its capacity to yield large volumes of water necessary for public use. Bedrock is of secondary consideration because it characteristically yields small volumes of water generally not suitable for public demand. However, in vicinity of the Station, fractured bedrock is the only present water-bearing strata. The nearest outcrop of a stratified glacial aquifer identified in the PA is approximately 0.66 miles to the south of the Station.

Groundwater within the fractured bedrock aquifer is unconfined within the limits of the fracture system, but occasionally artesian conditions do exist. General groundwater movement can be determined locally by the topography. Groundwater movement is interpreted as occurring perpendicular to surface elevation contours. Due to the high topographic position of the Station, general groundwater movement likely occurs downgradient to the northwest and southwest from the Station. The depth to the water-table at this location is estimated at 30 to 50 feet below land surface (BLS).

3.6 SURFACE WATER

Surface water on the Station property drains overland, and the drainage can be divided into two basic units. Roughly, the northeast one-third of the Station property drains northeast while the southwest two-thirds drains north and northwest. Surface water in the northeast one-third flows overland to the northeast and exits the Station property along the northeastern boundary. From this point, surface water flows north along natural drainage pathways down the slope of Millstone Hill. The remainder of the surface flow from the northeast is in a westerly direction along the Parkway before reaching another small pond located near the intersection of Parkway and Rodney Streets. In the southwestern two-thirds of the Station, surface water drains overland to the west and northwest. Surface water exits the Station property along the northwestern boundary where it flows in a general north/northwesterly direction down Millstone Hill along natural drainage pathways. All surface water from the Station outflows overland except water that is collected from the roof of the main building and transported underground where it exits along the northwestern boundary and then follows the flow route described for the southwestern two-thirds of the Station.

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SECTION 4.0 FIELD PROGRAM

The purpose of this Addendum SI was to confirm, through field activities, the presence or absence of contamination that may be associated with the former dry well located north of Building 001, and, if contamination was detected, to define the relationship between contamination at the Addendum Site and contamination detected during the initial SI. Additionally, soil samples collected from specified soil borings were used to assess background conditions applicable to the Station. This section describes the field investigation performed during the Addendum SI to accomplish the above objectives, and the methodologies used to conduct these activities. The field investigation for the Addendum SI at the Worcester ANGS began on 3 April 1995 and was completed on 6 April 1995.

The field investigation program utilized the drilling of soil borings to obtain soil samples for field screening using a photoionization detector (PID) and a field gas chromatograph (GC), soil sample analysis confirmation by an analytical laboratory was conducted, and subsequent surveying of each soil boring was performed to determine boring locations and elevations.

4.1 FIELD SCREENING ACTIVITIES

Soil samples were collected using a California-style split-spoon sampler. Once sample collection was completed, the sampler was placed on a clean, plastic-covered table. Approximately 20 grams of soil was immediately obtained from the shoe of the sampler and placed in a 40-milliliter (ml) glass volatile organic analysis (VOA) vial to be used for ambient temperature headspace analysis (ATHA). An additional 40-ml VOA vial of soil was obtained from the shoe of the sampler and immediately placed in a cooled ice chest to be submitted to the GC technician for screening using the field GC. The PID was then used to detect volatile compound concentrations as the split-spoon sampler was opened. This allowed for the maximum initial detection of volatile compounds in the soil sample. The soil samples were then retrieved from the sampler and prepared for shipment to the laboratory as outlined in Subsection 4.2.3.3.

Soil samples obtained during the Addendum SI were field screened using a Photovac MicroTip™ PID immediately upon opening the split-spoon (to maximize the detection of volatiles) to conduct ATHA. A portion of the soil was then screened using a Photovac 10S+™ field GC calibrated for benzene, toluene, ethylbenzene, and total xylenes (BTEX).

When conducting ATHA, the vial of soil was placed in a protected area for at least 15 minutes and allowed to reach an ambient temperature of approximately 20 degrees Centigrade (20° C).

The vial was then shaken from side to side to break up the soil and liberate any volatile compounds present. The top the vial was then opened to allow the tip of the PID to be inserted and the ATHA reading was recorded.

When conducting screening with the field GC, 10 grams of soil were obtained from the vial collected for field GC analysis. The soil was placed in a 40-ml VOA vial with 10 ml of American Society of Testing and Materials (ASTM) Type II reagent water and placed in a heated water bath maintained at a constant 25° C. The vial was then shaken from side to side to assist in breaking up the soil. A glass syringe was then used to obtain a 100-microliter volume of headspace vapor through the septa of the vial and injected into the field GC (calibrated for BTEX) for detection of the presence of volatiles.

PID readings obtained during the initial spoon opening and by ATHA are indicated on the boring logs included in Appendix A. Field GC data is summarized in Subsection 5.3.1, and complete field GC results, including chromatograms, are presented in Appendix B.

4.2 CONFIRMATION ACTIVITIES

Technical Drilling Services, Inc. (TDS), Clinton, Massachusetts, was retained as the subcontractor for drilling boreholes. The drilling subcontractor mobilized personnel and equipment that met all Massachusetts ANG and Massachusetts Department of Environmental Protection (MADEP) requirements.

NyTest Environmental, Inc. (NEI), Port Washington, New York, was retained to perform laboratory analyses. NEI is certified by the Commonwealth of Massachusetts to perform laboratory analysis. Provisions were made for proper sample containers, labels, chain-of-custody forms, sample stabilization and preservation, and insulated sample containers.

Tauper Land Survey, of Whitinsville, Massachusetts, was retained as the surveying subcontractor. The site boundaries, buildings, parking areas, and soil boring locations were surveyed. The land surface elevations of each borehole are shown on the borehole logs included in Appendix A. The land survey plats prepared by the surveyor are presented in Appendix C.

4.2.1 Background Soil Sampling

An evaluation of the significance of environmental contaminant concentrations is typically based on a comparison between the levels observed and the known background conditions and regulatory-based standards. Sampling of soil at a background location was conducted to assist in assessing naturally-occurring concentration levels, and contaminant or chemical concentrations already existing in the area due to general environmental conditions. Establishing soil background levels is necessary for risk assessment, establishing cleanup criteria, and making decisions on further site actions. Background locations were located away from any known Station sources of contamination and should provide information on background levels. Analytical results obtained during this sampling event represent background levels against which contaminant concentrations detected at the site will be compared and the significance of detected contamination determined.

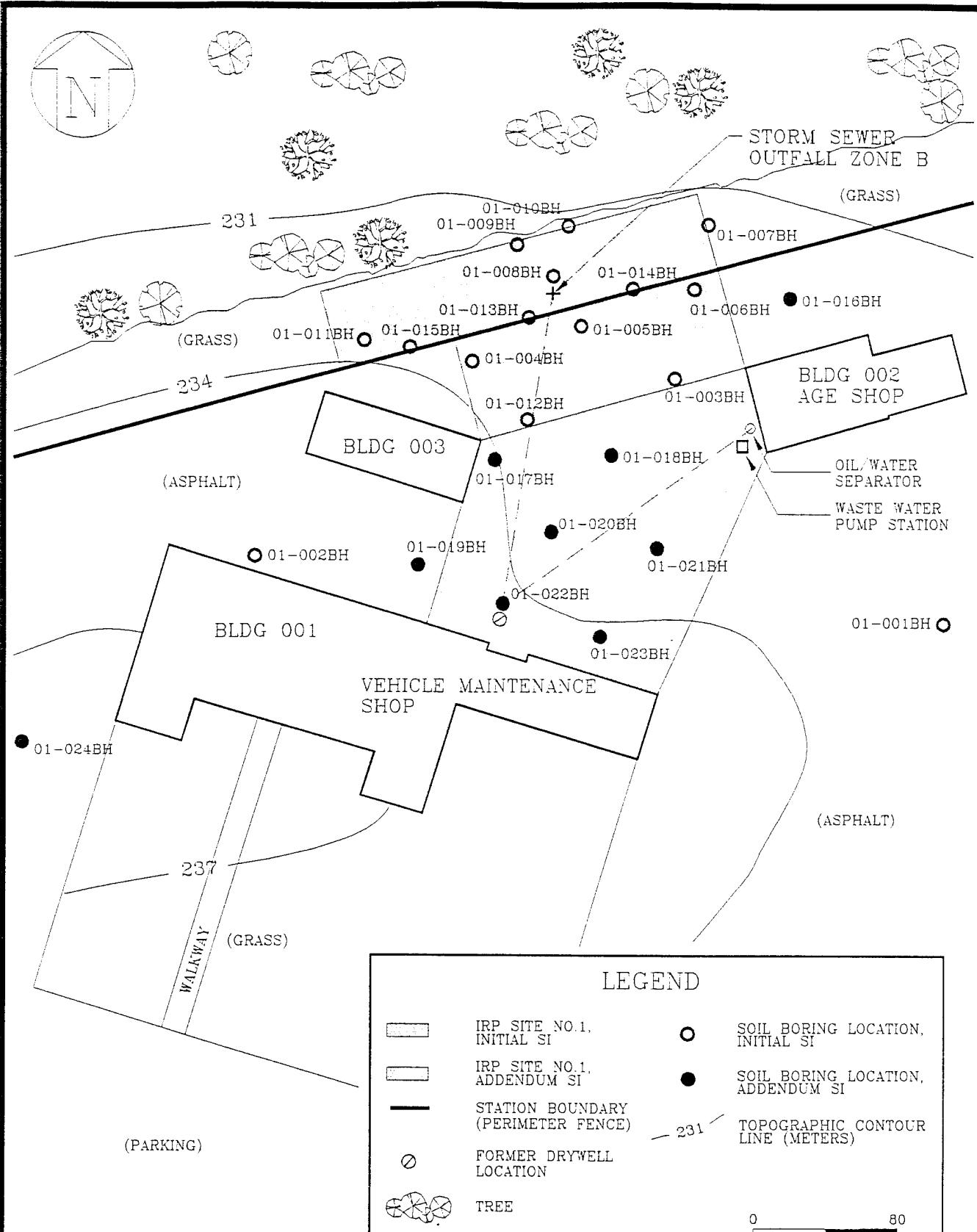
Background data at the Worcester ANGS consisted of one soil boring which was used to obtain soil samples for laboratory analysis. Due to the depth to bedrock at the background sampling location, one soil sample was collected from below the asphalt surface to immediately above the bedrock surface. This soil sample was used to characterize subsurface soil and geological conditions at the Station. Actual samples and depths submitted for laboratory analysis are discussed in Section 5.2, Background Sampling, and are shown on the borehole logs included in Appendix A.

4.2.2 Addendum SI Soil Borings

4.2.2.1 Soil Boring Locations

Nine soil borings were installed at the Addendum Site to obtain soil samples for laboratory analysis. Analytical results were used to define any existing soil contamination, to aid in defining the vertical and horizontal extent of contamination, and to assist in assessing environmental background levels at the Station (Figure 4.1). Soil samples were also used for characterizing site geology and subsurface soil conditions. All soil borings were drilled as closely as possible to their originally proposed locations as specified in the SI Work Plan.

Soil boring 01-016BH was drilled north of Building 002 (AGE Building) between the building and the Station perimeter fence. The boring was placed approximately 50 feet east of the initial IRP Site No. 1 boundary and was used to provide information of the eastern extent of TPH contamination detected during the initial SI at the site.



SOURCE: TAUPER SURVEY, 1993.

FIGURE 4.1

WORCESTR\SBOR-LOC

SOIL BORING LOCATIONS
AT IRP SITE NO. 1
101st ACS and 212th EIS
Worcester Air National Guard Station
Worcester, Massachusetts

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Soil borings 01-017BH, 01-018BH, and 01-020BH were located south of the initial IRP Site No. 1 boundary between the initial IRP site and the dry well. Boring 01-022BH was located immediately north (topographically downslope) of the former location of the dry well. The boring was located based on reports from Station personnel as to the exact location of the former dry well. These borings were specifically located to determine if contamination from the former dry well is present, and if contamination is detected, to determine the relationship between contamination detected during the Addendum SI and during the initial SI.

Soil borings 01-019BH, 01-021BH, and 01-023BH were located on the western, northeastern, and eastern perimeters of the Addendum Site, respectively, to assist in determining the lateral extent of contamination associated with the dry well.

Soil boring 01-024BH was located upslope of the site and away from known contamination source areas to obtain background samples as described in Subsection 4.2.1.

4.2.2.2 Soil Boring Methodology

Soil borings were installed to collect soil samples for laboratory analysis. The analytical results will be used to define the vertical and horizontal extent of contaminants at the Addendum Site. Soil samples were also used for determining site geology and subsurface soil characteristics.

A total of nine soil borings, including a background soil boring, were installed. All work was performed in a manner consistent with MADEP regulations. Depth of the soil test borings was limited to the depth where granitic bedrock was encountered. All borings were drilled using hollow-stem auger (HSA) methods to collect samples. Soil samples were collected in discrete intervals using a California-style split-spoon sampler fitted with brass sleeves to containerize the soil.

The HSA drilling method employs a hollow helical steel drill tool that is rotated to advance the boring and lift formation materials (cuttings) to the surface. The flights for the HSA are welded onto steel pipe and a cutter head is attached to the "lead" (bottom) auger to cut the hole. During drilling, a center bit is inserted into the hollow area of the cutter head that prevents cuttings from re-entering the hollow portion of the auger. Generally, the center bit is flush with or extends no more than 1/2 foot below the cutter head. The center bit connects through the auger by small diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight

of augers. The hollow opening allows the insertion of sampling tools (i.e., split-spoon sampler) with the augers in place to prevent caving of the borehole.

Due to the shallow nature of the bedrock at many of the sampling locations, the HSA was used to penetrate the asphalt surface and road base material to expose soil for the first sampling interval. Actual drilling with augers was not necessary except at the 01-016BH, 01-017BH, and 01-018BH locations. For the other locations, the overburden thickness was thin enough such that the California-style split-spoon could be sent and retrieved without using the augers to advance the borehole.

Soil samples were collected below the asphalt surface and above the bedrock for subsurface characterization and field screening. An 18-inch carbon steel California-style sampler equipped with three 6-inch brass sleeves was used for collecting soil samples for laboratory analysis. Actual sample depths submitted for laboratory analysis are discussed in Subsection 5.3.2, and shown on the borehole logs in Appendix A. The California-style sampler was decontaminated and new brass sleeves inserted before each sampling event.

Auger flights, the rear of the drill rig, and tools along with the split-spoon sampler were thoroughly steam-cleaned in the designated decontamination area at the northwest end of Building 002 before initial use and after the completion of each borehole.

Borehole abandonment activities conformed to applicable Massachusetts requirements. HSA borings were backfilled with bentonite/cement grout, after the sampling had been completed, to prevent the downward migration of contaminants through the open borehole.

Soil boring locations and ground elevations were determined by a certified land surveyor. The survey plat of the Addendum Site is included in Appendix C.

4.2.3 Specific Media Sampling

This section summarizes the analytical program followed for soil samples collected during the Addendum SI. Soil samples were collected to determine the nature, magnitude, and extent of contamination at the Addendum Site. Also included in this section is a brief discussion of quality control procedures followed during the field sampling activities.

4.2.3.1 Soil Analytical Program

Potential contaminants disposed in the OWS north of Building 001 consisted primarily of waste oil, organic solvents, and fuels (diesel, MOGAS, JP-4, and JP-5). Therefore, the primary analytical program of the SI focused on the detection of volatile organic compounds (VOCs), SVOCs, TPH, and lead.

To comply with MADEP requirements and to remain consistent with the previous SI conducted at the Station, all soil samples collected during the Addendum SI were analyzed for VOCs by Environmental Protection Agency (EPA) Method SW8240; SVOCs by EPA Method SW8270; priority pollutant metals by EPA Method SW6010, with the exception of arsenic (SW7060), cadmium (SW7131), lead (SW7421), mercury (SW7470), selenium (SW7740), and thallium (SW7841); TPH by EPA Method 418.1; and polychlorinated biphenyls (PCBs) by EPA Method SW8080. Table 4.1 summarizes the laboratory confirmation analyses conducted for the Addendum SI, and Table 4.2 presents analytical Quality Assurance/Quality Control (QA/QC) sampling that was conducted.

Table 4.1
Laboratory Analyses Summary Table
101st ACS, Worcester ANGS, Worcester, Massachusetts

Site No.	Matrix	Field Parameters	Lab Parameters	Analytical Methods	Investigating Samples
1	Soil (Subsurface)	Soil Screening using PID/Field GC, Soil Classification	VOCs SVOCs TPH Metals PCBs	SW8240 SW8270 418.1 SW6010 ^a SW8080	13

VOCs – Volatile Organic Compounds.

SVOCs – Semivolatile Organic Compounds.

TPH – Total Petroleum Hydrocarbons/USEPA 600/418.1.

PID – Photoionization Detector.

GC – Gas Chromatograph.

PCBs – Polychlorinated Biphenyls.

^aWith the exception of: Arsenic (SW7060); Cadmium; SW7131); Lead (SW7421); Mercury (SW7470); Selenium (SW7740); and Thallium (SW7841).

4.2.3.2 Quality Control of Field Sampling

Field duplicate, field blank, equipment blank, and trip blank samples were submitted to the laboratory for assessment of the quality of data resulting from the field sampling program. Field and trip blank samples were analyzed to check for procedural contamination and ambient conditions at the site that may have caused sample contamination. Duplicate samples were submitted to provide a Quality Assurance (QA) check on analytical procedures and results.

Matrix samples provide information about the effect of the sample matrix on the analytical methodology.

Table 4.2
Laboratory QA/QC Analyses Summary Table
101st ACS, Worcester ANGS, Worcester, Massachusetts

Trip Blanks	Equipment Blanks	Field Blanks	Field Duplicates	MS/MSD	Matrix Totals
4*	2	2	2	1	7

* – Trip Blanks are not counted in Matrix Totals.

MS/MSD – Matrix Spike/Matrix Spike Duplicate.

The level of the Quality Control (QC) included one field duplicate, one field blank, and one equipment blank for every 10 or fewer investigative samples. One matrix spike/matrix spike duplicate (MS/MSD) was collected for every 20 or fewer investigative samples. One VOC analysis trip blank, consisting of distilled, de-ionized, ultra-pure water, was included along with each shipment of samples.

4.2.3.3 Sample Collection and Preservation

Soil samples submitted for laboratory analysis were contained in brass sleeves. Immediately upon removal from the sampler, the sleeve ends were covered with a Teflon™ barrier, aluminum foil (shiny side facing outward) and fitted with a plastic cap. Prepared samples were placed in a sealed zip-lock plastic bag and immediately placed in a cooler filled with ice to maintain a temperature of 4°C. No chemical preservatives were used.

Equipment blanks and field blanks were collected as aqueous samples. VOC samples were preserved with no more than 2 drops of a 1:1 solution of hydrochloric acid in each of two 40-ml glass VOA vials with Teflon™-lined lids. SVOC samples were stored in two 1/2-liter amber glass bottles with Teflon™-lined lids, and no preservatives. Total recoverable metal samples were stored in 1/2-liter high-density polyethylene bottles with Teflon™-lined lids, and preserved with a solution of 1:1 nitric acid to achieve a pH of less than 2. TPH samples were stored in two 1/2-liter glass bottles having Teflon™-lined lids, and no preservatives, and PCB samples were stored in 1/2-liter glass bottles having Teflon™-lined lids, and no preservatives.

4.2.4 Equipment Calibration

4.2.4.1 Field Gas Chromatograph

The field GC was operated and standardized using a 100-part-per-billion (ppb) BTEX headspace sample for a 3-point calibration conducted each day prior to beginning sampling activities. This headspace standard was prepared daily by dilution of a 2,000-parts-per-million (ppm) BTEX stock solution. After approximately five sample analyses, the GC calibration was checked periodically during usage throughout the day. Air blank samples were also used to assess any problems with sample or standard cross-contamination.

4.2.4.2 Photoionization Detector

Calibration of the PID was performed at the start of each day using 100 ppm isobutylene, a standard calibration gas. Additional calibrations were made during the day if the unit's readings became erratic or if the unit was turned off for an extended period of time. Calibration procedures were performed as outlined in the manufacturer's instructions.

4.3 FIELD DOCUMENTATION AND INFORMATION COLLECTION

Daily field reports were submitted to the HQ ANG/CEVR Project Manager outlining the days activities. Verifiable sample custody was an integral part of the field work. Samples were properly collected and identified, and sampling activities were carried out in accordance with the Addendum Work Plan. All information pertinent to field observations, screening, and sampling were indelibly recorded in a bound notebook. Each member of the project team maintained a field notebook in which details of daily field activities were recorded. A complete record of these field notebooks, daily field reports, and other field forms are presented in Appendix C.

4.4 INVESTIGATION DERIVED WASTE

During the SI, a certain amount of waste material (drill cuttings and purge water) were produced as a result of investigative activities. Drill cuttings were produced during the installation of soil borings. Drill cuttings were preliminarily characterized by monitoring for organic vapor emissions with the PID and screening with the field GC. Nonetheless, all soil cuttings were drummed in a steel, 55-gallon drum labeled as "soil cuttings" at the time of drilling. Additionally, one drum of decontamination water was collected during the SI. Water from the

steam cleaning of augers and washing of sampling equipment was containerized in a steel, 55-gallon drum labeled as "decontamination water."

Miscellaneous derived wastes (e.g., gloves, Visqueen™ sheeting, and wipes) which came in contact with drill cuttings having PID readings less than 100 ppm, when field screened as described in Section 4.1, were disposed of in a general refuse container.

The two drums were properly marked to indicate their contents, the collection date, contractor's name and telephone number, and borehole identification numbers. The final disposition of drummed materials is discussed in Appendix D of this Report.

4.5 DEVIATIONS FROM THE WORK PLAN

There were no deviations from the Work Plan noted. The drilling and sampling program, as outlined in Subsection 6.3.2 of the Addendum SI Work Plan, was modified as required by the specific conditions at the site identified in the Work Plan. Soil samples could not be collected at 5-foot intervals at most locations due to the shallow nature of the bedrock. At several locations, the soil horizon was too shallow to provide two separate sampling intervals. In all cases, however, the objective of collecting a sample below the land surface and immediately above the bedrock surface was accomplished.

SECTION 5.0 INVESTIGATIVE FINDINGS

5.1 SUBSURFACE GEOLOGY

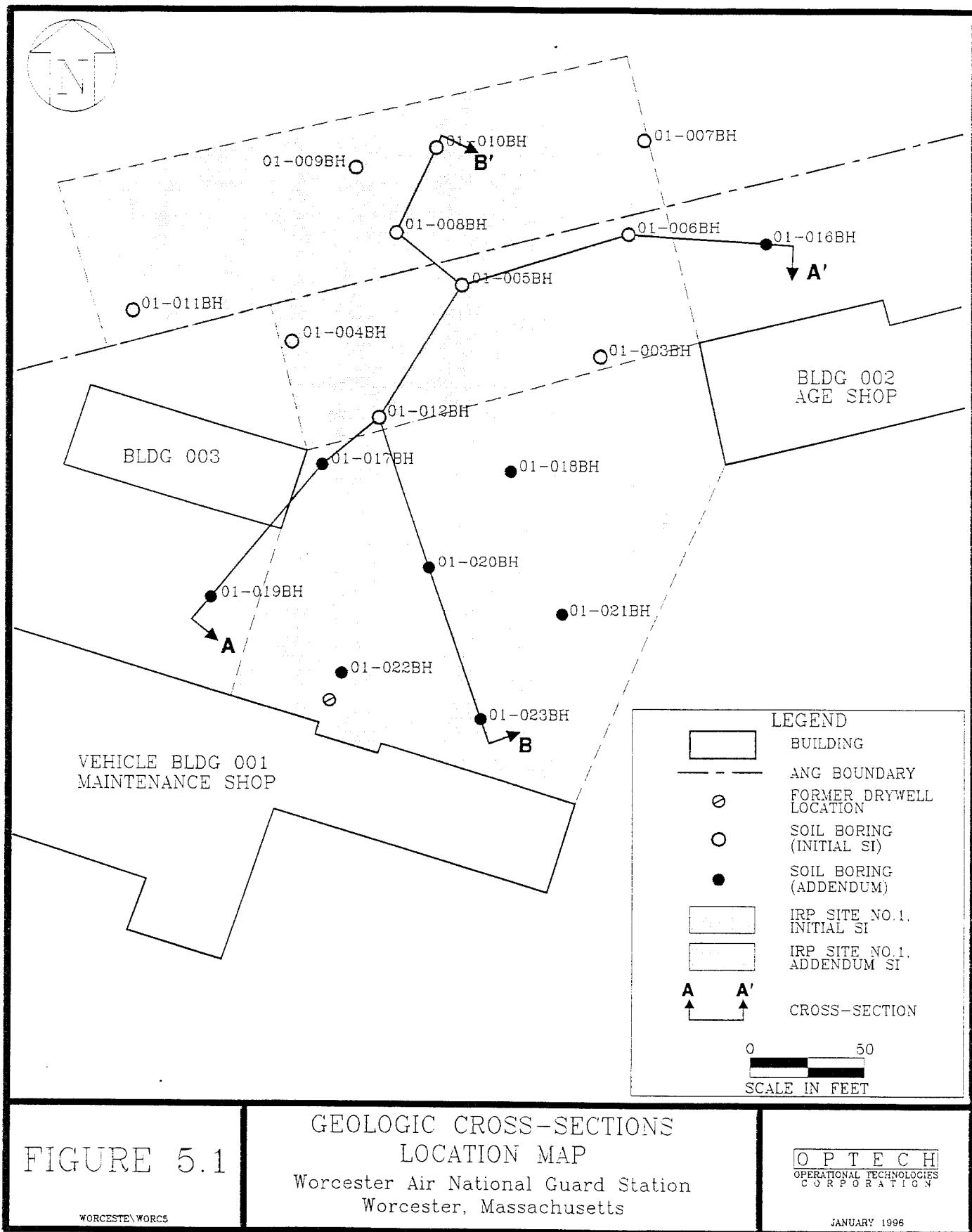
Soil samples collected from soil borings (including the background soil boring) were used to provide geologic information for describing the subsurface geology at the Station and for the Addendum Site. Complete lithologic logs for the holes drilled during this investigation are presented in Appendix A.

The soil beneath the asphalt parking and vehicle driveway areas of the Addendum Site was predominantly a fill material graded from nearby existing soil. The fill material consisted of a coarse- to medium-grain quartz sand with well rounded to subangular gravel and bedrock granite fragments. Native soil, consisting of unsorted sand and silt, was encountered above the bedrock surface in some borings. The soil horizon (fill material and native soil) thickens northward from a thickness of 1.0 to 2.0 feet at 01-021BH and 01-020BH, 01-022BH, 01-023BH and 01-024BH to a maximum thickness of 9.0 feet near the perimeter fence at 01-016BH. Soil boring cross section locations are shown in Figure 5.1. Cross sections depicting the subsurface geology, which include boring information obtained during the initial SI, are shown in Figure 5.2 and Figure 5.3. Saturated soil was not encountered at any boring location at the Addendum Site.

5.2 BACKGROUND SAMPLING

Background data available during the Addendum SI consisted of one soil boring, 01-024BH, which was used to obtain soil samples. Due to the depth to bedrock, one soil sample was collected for laboratory analysis to assist in assessing naturally-occurring concentration levels, and contaminant or chemical concentrations already existing in the area. The location chosen for the background sample was away from known areas of contamination and was located hydraulically upgradient of the site. Field screening of the background soil sample indicated only low levels of VOCs were detected.

Soil boring 01-024BH was drilled and sampled on 5 April 1995 to a depth of 2.0 feet BLS where bedrock was encountered. The soil was a light brown, coarse-to medium-grain quartz sand (possibly fill material), with some angular gravel and granite fragments. Saturated conditions were not encountered at this borehole location.



NORTHEAST
A
SOUTHWEST
A

ELEVATION (FEET ABOVE MEAN SEA LEVEL)

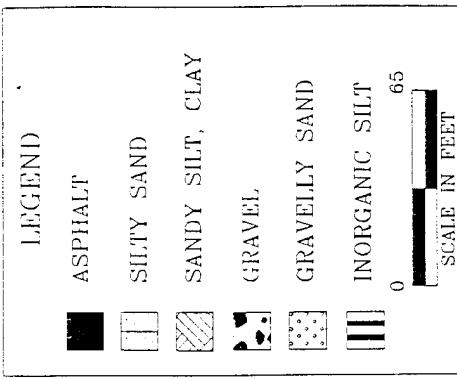
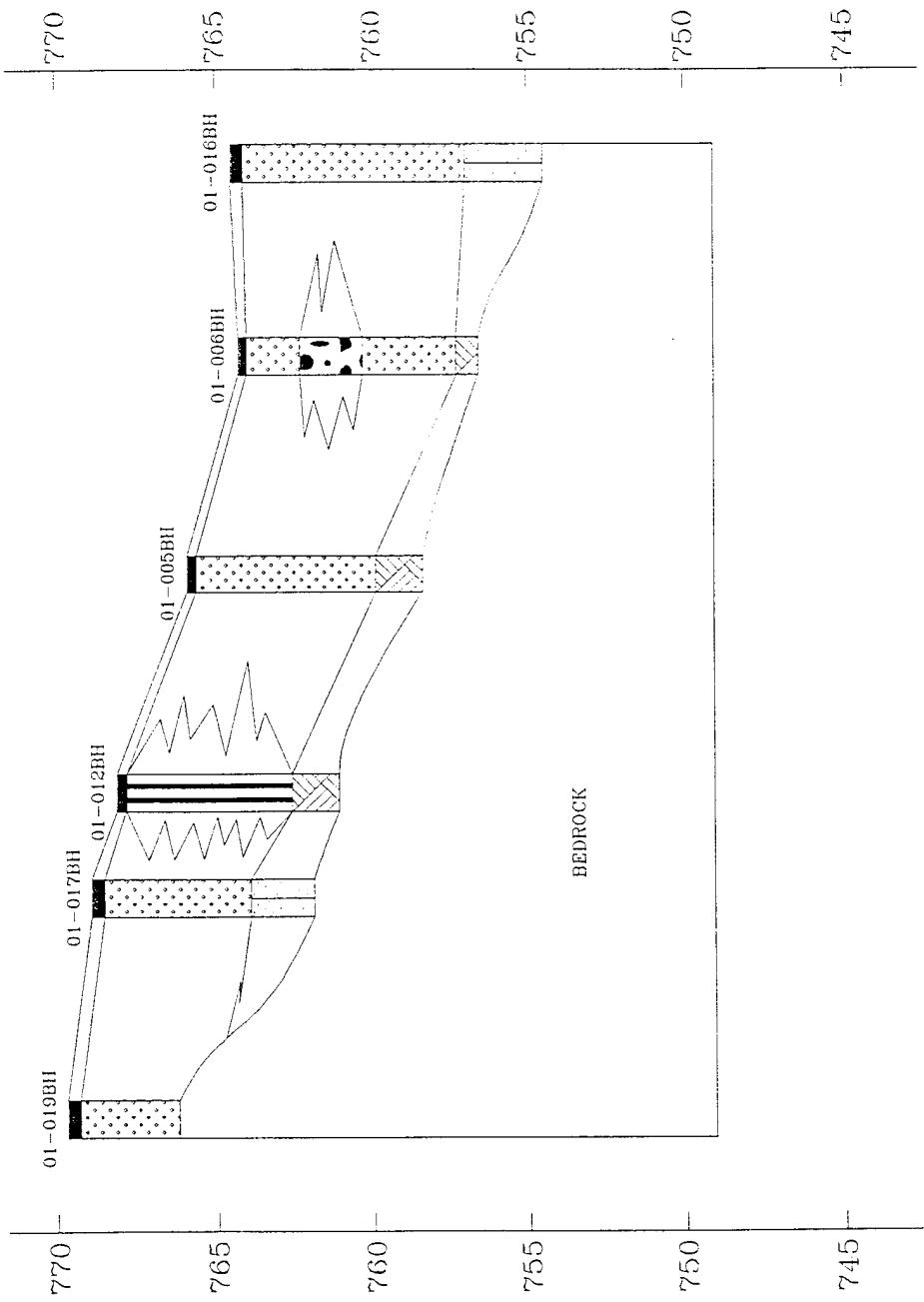
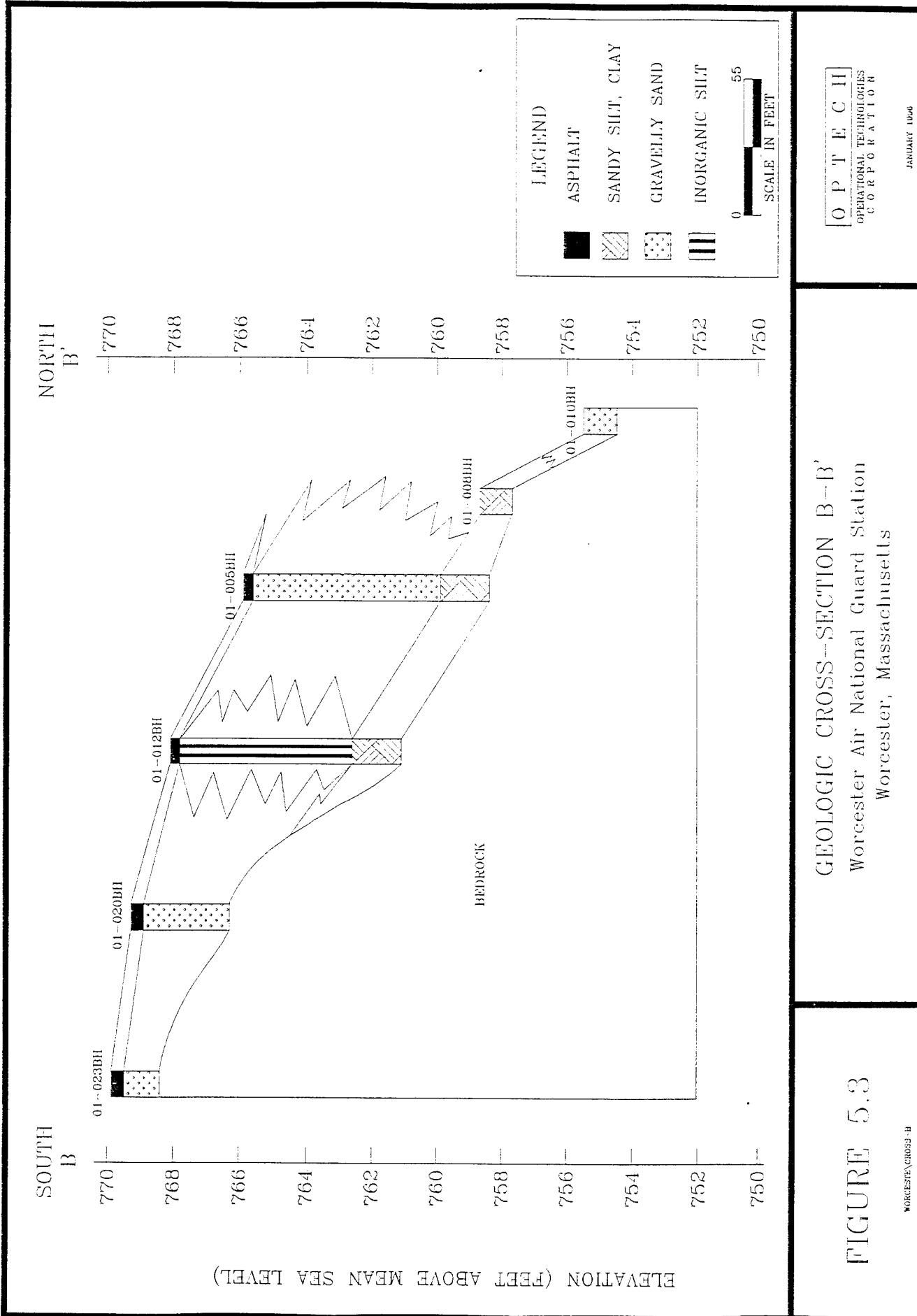


FIGURE 5.2

GEOLOGIC CROSS-SECTION A-A'
Worcester Air National Guard Station
Worcester, Massachusetts

O P T E C II
OPERATIONAL TECHNOLOGIES
CORPORATION



5.2.1 Field Screening Results

The soil sample obtained from boring 01-024BH was field screened using the field GC. Total BTEX detection was 24 ppb; benzene was detected at 3 ppb; toluene was detected at 2 ppb; ethylbenzene was detected at 2 ppb; m,p-xylene was detected at 11 ppb; and o-xylene was detected at 6 ppb. Complete field GC data is included in Appendix B.

5.2.2 Analytical Results

Soil sample analytical data of 01-024BH did not indicate the presence of VOCs, SVOCs, or PCBs. Analytical data also indicated the presence of TPH at 20 milligrams per kilogram (mg/kg) which may reflect effects of the asphalt/road base cover.

Metal analyses indicated nine of thirteen metals were detected in excess of the analytical method detection limits (AMDLS). Arsenic was detected at 9.3 mg/kg, beryllium at 0.49 mg/kg, chromium at 24.8 mg/kg, copper at 20.7 mg/kg, lead at 16.6 mg/kg, mercury at 0.13 mg/kg, nickel at 11.5 mg/kg, and zinc at 51.5 mg/kg. None of the thirteen metals exceeded MCP/RCs in the background soil sample.

Table 5.1 summarizes the analytes detected in soil samples collected from the background location. A complete listing of the results for all analytical parameters for each sample is given in Appendix E.

5.3 ADDENDUM SITE SAMPLING

The Addendum area of IRP Site No. 1 extends the original boundaries of the site southward approximately 75 feet as outlined in Subsection 2.3.2.

All portions of the Addendum Site are within the Station boundary. The Addendum Site is asphalt paved and used as an accessway to the maintenance shops in Building 001 and as a parking area for military vehicles.

5.3.1 Field Screening Results

A total of 12 soil samples at the Addendum Site were field screened with a Photovac 10S+ field GC calibrated to screen for BTEX. Table 5.2 summarizes the maximum concentrations detected in soil samples and includes the MCP/RCs for reference. Complete GC data is included in Appendix B.

Table 5.1
Analytes Detected in the Background Soil Sample
101st ACS, Worcester ANGS, Worcester, Massachusetts

Component	Analytical Method	01-024BH 0.5 - 2.0 (ft BLS)	Action Level* (mg/kg)
TPH	418.1	20.0	2,500.0
Metals:			
Arsenic	7060	9.3	30.0
Beryllium	6010	0.49	0.8
Cadmium	7131	0.12B	80.0
Chromium	6010	24.8	2,500.0
Copper	6010	20.7	10,000.0
Lead	7421	16.6	600.0
Mercury	7470	0.13	60.0
Nickel	6010	11.5	700.0
Zinc	6010	51.5	2,500.0

Analyte Concentrations expressed in milligrams per kilogram.

* - Massachusetts Contingency Plan

BH - Borehole.

ft BLS - feet below land surface.

TPH - Total Petroleum Hydrocarbons.

B - Reported value obtained from reading less than the contract required detection limit, but greater than or equal to the instrument detection limit.

Table 5.2
Maximum Field GC Concentrations Detected in Soil Samples
101st ACS, Worcester ANGS, Worcester, Massachusetts

Compound	Maximum Concentrations Detected in Soil Samples (ppb)	Maximum Concentration Soil Sample Location and Depth (ft-BLS)	Action Levels* (µg/kg)
Benzene	9	01-021BH (0.5 - 2.0) and 01 - 023BH (0.5 - 2.0)	60,000
Toluene	9	01-022BH (0.5 - 2.0)	500,000
Ethylbenzene	9	01-022BH (0.5 - 2.0)	500,000
m,p-Xylene	56	01-022BH (0.5 - 2.0)	500,000
o-Xylene	28	01-022BH (0.5 - 2.0)	500,000

GC - Gas Chromatograph.

BH - Borehole.

* - Massachusetts Contingency Plan

ppb - parts per billion.

ft BLS - feet below land surface

µg/kg - micrograms per kilogram

Total BTEX was detected at concentrations ranging from 5 to 106 ppb in 10 of the 12 soil samples analyzed. One soil sample, 01-018BH (0.5 - 2.0), had no BTEX detected, and 01-016BH (7.5 - 9.0) had BTEX detected at concentrations exceeding the calibration range of

the field GC, resulting in actual analyte peak concentrations not being available for that sample. Benzene was detected ranging from 1 to 9 ppb in nine of the samples; toluene was detected ranging from 1 to 9 ppb in 10 of the samples; ethylbenzene was detected ranging from 1 to 9 ppb in seven of the samples; m,p-xylene was detected ranging from 3 to 56 ppb in seven of the samples; and o-xylene was detected ranging from 3 to 28 ppb in four of the samples. Table B.1 in Appendix B presents the field GC data summary. Complete field GC results, including chromatograms, are presented in Appendix B.

5.3.2 Analytical Results

Soil samples collected from the 8 soil borings at the Addendum Site were used to provide geologic information for describing the subsurface geology at the site (Figure 4.1). A total of 14 soil samples (11 investigative, 1 background, and 2 duplicate) were submitted for laboratory analysis to characterize and define contamination at the Addendum Site. The borings were drilled and soil samples collected on 4 and 5 April 1995. Sampling intervals submitted for laboratory analysis and the analytical program are presented in Table 5.3.

Validity of samples concerning volatile and semivolatile fractions were all within acceptable QC limits. All volatile and semivolatile surrogate and MS/MSD recoveries met QC criteria. No analytical problems were encountered among the sample and QA/QC analyses. The validity of PCB, TPH and metal analyses were all within acceptable QA criteria among surrogate and Matrix Spike (MS) recoveries.

A complete listing of OpTech data validation reports, laboratory summary narratives, soil sample analytical results, analytical QA/QC, and chain-of-custody forms is presented in Appendix E.

5.3.2.1 VOC Contamination

VOC contamination was detected in 9 of the 14 soil samples from the Addendum Site submitted for analysis. Four of the samples indicated individual VOC concentrations detected above AMDLs, however no compounds were detected above action levels. Table 5.4 lists the boring locations and sample intervals where VOCs were detected. MCP/RCS are also listed for comparison. Complete VOC analytical results and quality control samples are listed in Appendix E.

Table 5.3
Soil Sampling and Analytical Program
101st ACS, Worcester ANGS, Worcester, Massachusetts

Borehole Number	Sample Depth (ft BLS)	Additional Samples	Soil Analyses and Methods				
			VOCs (SW8240)	SVOCs (SW8270)	TPH (418.1)	PCBs (SW8080)	Metals (6010) ^a
01-016BH	0.5 - 2.0		X	X	X	X	X
01-016BH	0.5 - 2.0	Duplicate	X	X	X	X	X
01-016BH	7.5 - 9.0		X	X	X	X	X
01-017BH	0.5 - 2.0		X	X	X	X	X
01-017BH ^b	0.5 - 2.0	MS/MSD	X	X	X	X	X
01-017BH	5.0 - 7.5		X	X	X	X	X
01-018BH	0.5 - 2.0		X	X	X	X	X
01-018BH	5.0 - 6.0		X	X	X	X	X
01-019BH	0.5 - 2.0		X	X	X	X	X
01-019BH	2.0 - 3.5		X	X	X	X	X
01-020BH	0.5 - 2.0		X	X	X	X	X
01-021BH	0.5 - 1.0		X	X	X	X	X
01-022BH	0.5 - 2.0		X	X	X	X	X
01-022BH	0.5 - 2.0	Duplicate	X	X	X	X	X
01-023BH	0.5 - 1.5		X	X	X	X	X
01-024BH ^c	0.5 - 2.0		X	X	X	X	X
		Equip. Blank (2)	X	X	X	X	X
		Field Blank (2)	X	X	X	X	X
		Trip Blank (4)	X	N	N	N	N

^aWith the exception of: Arsenic (SW7060); Cadmium (SW7131); Lead (SW7421); Mercury (SW7470); Selenium (SW7740); and Thallium (SW7841).

^bMS/MSD sample not counted in Addendum Site Investigative sample totals.

^cBackground soil sample not counted in Addendum Site Investigative sample totals.

VOCs – Volatile Organic Compounds.

MS/MSD – Matrix Spike/Matrix Spike Duplicate.

SVOCs – Semivolatile Organic Compounds.

PCBs – Polychlorinated Biphenyls.

BH – Borehole.

N – Indicates analysis was not run.

X – Indicates parameter was analyzed.

TPH – Total Petroleum Hydrocarbons.

BLS – feet below land surface.

Acetone, ethylbenzene, and xylenes were detected in two, one, and three soil samples, respectively, at concentrations exceeding AMDLs. Acetone was detected in soil from borings 01-016BH (7.5 - 9.0) and 01-018BH (5.0 - 6.0) at 16 micrograms per kilogram ($\mu\text{g}/\text{kg}$) and 31 $\mu\text{g}/\text{kg}$, respectively. Ethylbenzene, was detected in 01-016BH (7.5 - 9.0) at 130 $\mu\text{g}/\text{kg}$, and total xylenes were detected in 01-016BH (7.5 - 9.0), 01-017BH (5.0 - 6.0), and 01-022BH (0.5 - 2.0) at 870E $\mu\text{g}/\text{kg}$, 16 $\mu\text{g}/\text{kg}$, and 14 $\mu\text{g}/\text{kg}$, respectively. The "E" analytical flag on the 01-016BH analysis indicated xylene concentrations exceeded the calibration range of the analytical instrument. A dilution was conducted on the analysis (dilution factor: 5.0) and a new result of 1,100 $\mu\text{g}/\text{kg}$ was obtained for xylenes.

Benzene, toluene, chloroform, carbon tetrachloride, trichloroethene, 1,2-dichloroethene and 2-butanone were also detected at estimated volumes in soil samples from the Addendum Site. These concentrations indicate analytical results that were obtained which were less than the

sample quantitation limit, but greater than zero, and are also listed on Table 5.4 designated with the "J" analytical flag. Methylene chloride was detected in all soil samples and in associated analytical blanks at concentrations ranging from 4 to 14 µg/kg. Methylene chloride is a common laboratory solvent and, when detected at very low concentrations and found in analytical method blanks, is attributed to laboratory-induced contamination (USEPA, 1993). For this reason, methylene chloride is not shown on Table 5.4.

5.3.2.2 SVOC Contamination

SVOC contamination was detected in 5 of the 14 soil samples from the Addendum Site submitted for analysis. Two of these soil samples indicated individual compound concentrations in excess of MCP/RCs. Concentrations of SVOCs exceeding action levels are shown on Figure 5.4. Table 5.5 lists the boring locations and sample intervals where SVOCs were detected. Complete SVOC analytical results and quality control samples are listed in Appendix E.

Table 5.4
Semivolatile Organic Compounds Detected in Soil Samples*
101st ACS, Worcester ANGS, Worcester, Massachusetts

Semivolatile Organic Compounds	Action Levels** (µg/kg)	01-016BH 7.5 - 9.0 (ft BLS)	01-018BH 0.5 - 2.0 (ft BLS)	01-019BH 0.5 - 2.0 (ft BLS)	01-019BH 2.0 - 3.5 (ft BLS)	01-022BH 0.5 - 2.0 DUP (ft BLS)
Naphthalene	1,000,000	370J	3,500U	1,800U	1,800U	1,400U
2-Methylnaphthalene	7,000	720J	3,500U	1,800U	1,800U	1,400U
Acenaphthylene	2,000,000	3,700U	390J	1,800U	300J	1,400U
Fluorene	1,000,000	3,700U	470J	1,800U	220J	1,400U
Phenanthrene	100,000	800J	5,300	950J	2,800	1,400U
Anthracene	1,000,000	3,700U	1,300J	340J	880J	1,400U
Carbazole	NA	3,700U	3,500U	290J	490J	1,400U
Fluoranthene	600,000	1,500J	7,400	1,100J	6,600	270J
Pyrene	500,000	1,500J	7,700	780J	4,800	180J
Benzo(a)anthracene	1,000	840J	4,500	520J	3,800	1,400U
Chrysene	10,000	1,000J	5,600	550J	4,000	1,400U
Benzo(b)fluoranthene	1,000	790J	3,300J	430J	4,200	1,400U
Benzo(k)fluoranthene	700	580J	3,200J	430J	3,000	1,400U
Benzo(a)pyrene	700	740J	3,500J	540J	3,900	1,400U
Indeno(1,2,3-cd)pyrene	1,000	3,700U	1,600J	210J	1,100J	1,400U
Benzo(g,h,i)perylene	100,000	420J	1,600J	210J	1,000J	1,400U

*All analytes reported as microgram per kilogram

** - Massachusetts Contingency Plan.

U - Indicates compound was analyzed for but not detected. Detection limit is shown.

Bold - Indicates compound detected at concentrations greater than the action limit.

BH - Borehole.

ft BLS - feet below land surface.

J - Indicates an estimated volume. The result indicated is less than the sample quantitation limit (but greater than zero).

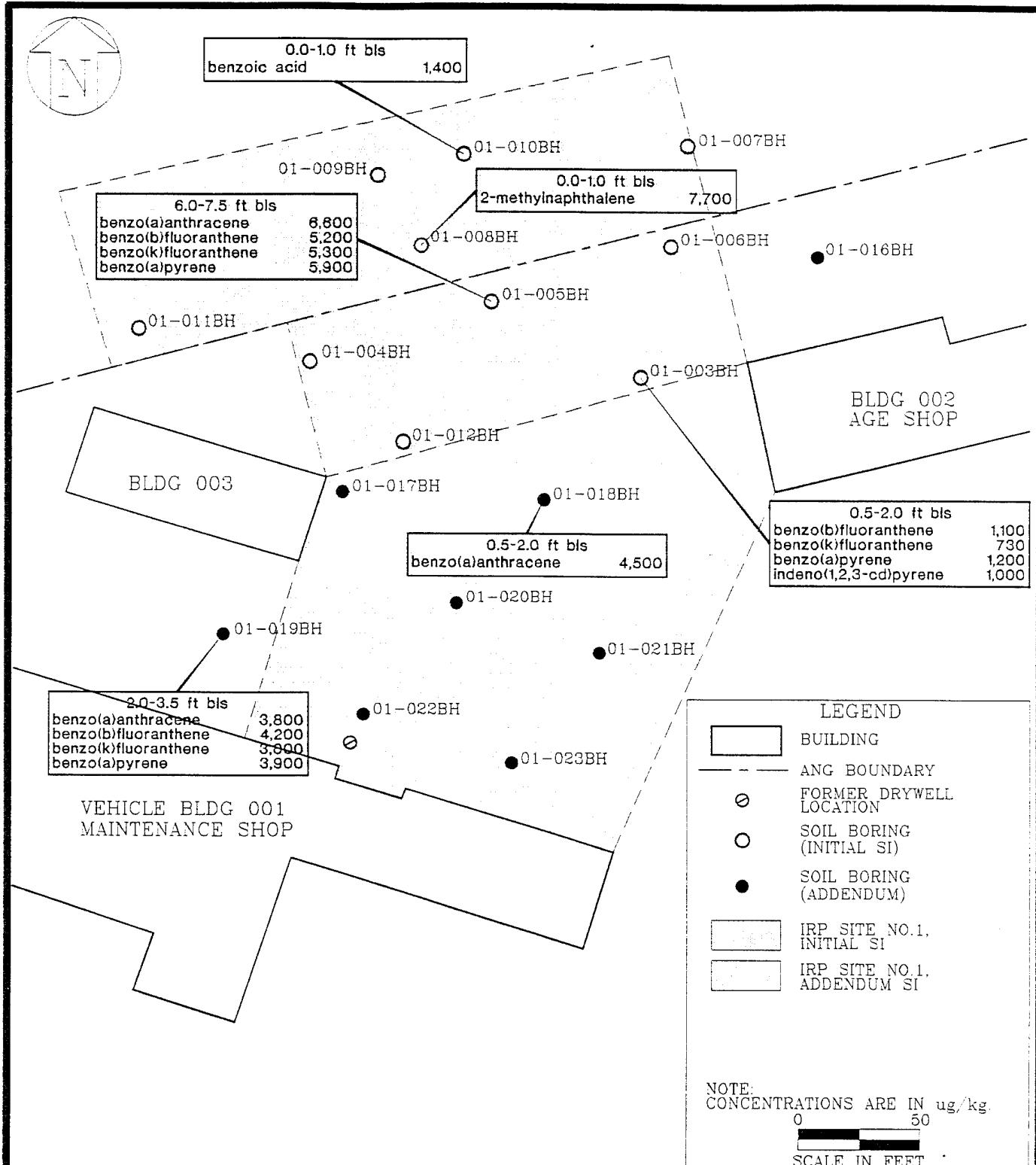


FIGURE 5.4

SVOCs DETECTED ABOVE ACTION LEVELS
AT IRP SITE NO.1

Worcester Air National Guard Station
Worcester, Massachusetts

WORCESTER WORC-199/WORCS

OPTECH
OPERATIONAL TECHNOLOGIES
CORPORATION

JANUARY 1998

Table 5.5
Volatile Organic Compounds Detected in Soil Samples*
101st ACS, Worcester ANGS, Worcester, Massachusetts

Volatile Organic Compound	01-016BH 0.5-2.0 (ft BLS)	01-016BH 0.5-2.0 (ft BLS) DUP	01-016BH 7.5-9.0 (ft BLS)	01-017BH 0.5-2.0 (ft BLS)	01-017BH 5.0-7.0 (ft BLS)	01-018BH 0.5-2.0 (ft BLS)	01-018BH 5.0-6.0 (ft BLS)	01-019BH 2.0-3.5 (ft BLS)	01-022BH 0.5-2.0 (ft BLS) DUP
Acetone (60)	7J	4J	16	10U	11U	10U	3J	11U	11U
Benzene (60)	10U	10U	2J	10U	11U	10U	11U	11U	11U
Toluene (500)	10U	10U	7J	4J	3J	10U	3J	J	2J
Ethylbenzene (500)	10U	10U	130	10U	4J	10U	11U	11U	J
Xylenes (500)	10U	10U	870E	10U	16	10U	11U	11U	14
Chloroform (10)	10U	10U	11U	1J	2J	10U	11U	11U	11U
Carbon (1000)	10U	10U	11U	2J	11U	10U	11U	11U	11U
Tetrachloride (1000)	10U	10U	11U	10U	11U	2J	2J	11U	11U
Trichloroethene (20)	10U	10U	11U	10U	11U	10U	J	11U	11U
1,2-Dichloroethene (500)	10U	10U	11U	10U	11U	10U	10J	11U	11U
2-Butanone (40)									

* - All analytes reported in micrograms per kilogram.

** - Massachusetts Contingency Plan.

ft BLS - feet below land surface.

J - Indicates an estimated volume. The result indicated is less than the sample quantitation limit (but greater than zero). (60) - MCP/RCs listed in parenthesis, micrograms per kilogram.

U - Indicates compound was analyzed for but not detected.

Detection limit is shown.

BH - Borehole.

E - Indicates the compound concentration exceeded the calibration range of the GC/MS. A dilution was conducted on this analysis (Dilution Factor: 5.0) and a result of 1,100 ug/kg was obtained for xylenes.

Boring 01-019BH (2.0 - 3.5) indicated the highest total concentration of SVOCs at 33,100 $\mu\text{g}/\text{kg}$. SVOCs detected were phenanthrene (2,800 $\mu\text{g}/\text{kg}$), fluoranthene (6,600 $\mu\text{g}/\text{kg}$), pyrene (4,800 $\mu\text{g}/\text{kg}$), benzo(a)anthracene (3,800 $\mu\text{g}/\text{kg}$), chrysene (4,000 $\mu\text{g}/\text{kg}$), benzo(b)fluoranthene (4,200 $\mu\text{g}/\text{kg}$), benzo(k)fluoranthene (3,000 $\mu\text{g}/\text{kg}$), and benzo(a)pyrene (3,900 $\mu\text{g}/\text{kg}$). SVOCs were also detected in soil from 01-018BH (0.5 - 2.0) at a total concentration of 30,500 $\mu\text{g}/\text{kg}$. SVOCs detected were phenanthrene (5,300 $\mu\text{g}/\text{kg}$), fluoranthene (7,400 $\mu\text{g}/\text{kg}$), pyrene (7,700 $\mu\text{g}/\text{kg}$), benzo(a)anthracene (4,500 $\mu\text{g}/\text{kg}$), and chrysene (5,600 $\mu\text{g}/\text{kg}$). Concentrations of SVOCs detected during this investigation that were of concern following the initial SI at IRP Site No. 1 are discussed in Section 5.4.

Additional SVOCs were detected at estimated concentrations below the sample quantitation limits but greater than zero and are designated with the "J" analytical flag as shown on Table 5.5. The sample from boring 01-016BH was diluted, resulting in higher method detection limits. The value for benzo(a)pyrene (740 J $\mu\text{g}/\text{kg}$) is greater than the MCP/RC of 700 $\mu\text{g}/\text{kg}$, but is estimated because it is below the method detection limit for that sample. When detected at very low concentrations, bis(2-Ethylhexyl) phthalate, is commonly attributed to laboratory-induced contamination. For this reason it is not shown in Table 5.4.

5.3.2.3 PCB Contamination

PCBs were not detected above method detection limits in any of the 14 soil samples submitted for analytical analysis. Two PCB compounds were detected in four soil samples at estimated concentrations less than the sample quantitation limit but greater than zero. Aroclor-1254 was detected at an estimated concentration of 49 $\mu\text{g}/\text{kg}$ in soil from 01-023BH (0.5 - 1.5) and Aroclor-1260 was detected at estimated concentrations of 52 $\mu\text{g}/\text{kg}$, 85 $\mu\text{g}/\text{kg}$, and 39 $\mu\text{g}/\text{kg}$ in soil from 01-016BH (7.0 - 9.5), 01-018BH (5.0 - 6.0), and 01-019BH (0.5 - 2.0), respectively.

5.3.2.4 TPH Contamination

TPH were detected in all investigative soil samples and two duplicate samples as summarized in Table 5.6. TPH concentrations ranged from 80 mg/kg at 01-023BH (0.5 - 1.5) to 6,300 mg/kg at 01-018BH (5.0 - 6.0). Only one sample contained TPH values higher than the action level of 2,500 mg/kg.

5.3.2.5 Metal Contamination

Eleven of the thirteen target metals were detected in soil samples from the Addendum Site.

Table 5.6
TPH Detected in Soil Samples
101st ACS, Worcester ANGS, Worcester, Massachusetts

Borehole	Sample Depth (feet BLS)	TPH (mg/kg)
01-016BH	0.5 - 2.0	140
01-016BH	0.5 - 2.0 Duplicate	120
01-016BH	7.5 - 9.0	1,300
01-017BH	0.5 - 2.0	95
01-017BH	5.0 - 7.0	110
01-018BH	0.5 - 2.0	130
01-018BH	5.0 - 6.0	6,300
01-019BH	0.5 - 2.0	340
01-019BH	2.0 - 3.5	230
01-020BH	0.5 - 2.0	190
01-021BH	0.5 - 1.0	140
01-022BH	0.5 - 2.0	110
01-022BH	0.5 - 2.0 Duplicate	730
01-023BH	0.5 - 1.5	80

BLS - Below land surface.

mg/kg - Milligrams per kilogram.

TPH - Total Petroleum Hydrocarbons.

limit. **Bold** - Indicates concentration above action

Cadmium and thallium were not reported above method detection limits in any soil samples, although cadmium was detected in several samples at estimated concentrations less than the contract required detection limit (CRDL), but greater than or equal to the instrument detection limit (IDL). Table 5.7 lists the priority pollutant metals detected in soil samples at the Addendum Site.

Antimony was detected above CRDLs in two samples at 6.1 mg/kg and 7.5 mg/kg. Arsenic was detected above CRDLs in all samples ranging from 12.6 to 59.4 mg/kg. Beryllium was detected above CRDLs in three samples ranging from 0.61 to 0.88 mg/kg. Chromium was detected above CRDLs in all samples ranging from 11.4 to 47.5 mg/kg. Copper was detected above CRDLs in all samples ranging from 10.0 to 52.2 mg/kg. Lead was detected above CRDLs in all samples ranging from 3.7 to 22.7 mg/kg. Mercury was detected above CRDLs in three samples ranging from 0.12 to 0.13 mg/kg. Nickel was detected above CRDLs in all samples ranging from 9.9 to 36.4 mg/kg. Selenium was detected above CRDLs in one sample at 0.54 mg/kg. Zinc was detected above CRDLs in all samples ranging from 21.7 to 57.8 mg/kg.

Table 5.7
Metals Detected in Soil Samples*
101st ACS, Worcester ANGS, Worcester, Massachusetts

Metals	Analytical Methods	01-016BH 0.5 - 2.0 (ft BLS)		01-016BH 0.5 - 2.0 DUP (ft BLS)		01-016BH 7.5 - 9.0 (ft BLS)		01-017BH 0.5 - 2.0 (ft BLS)		01-017BH 5.0 - 7.0 (ft BLS)		01-018BH 0.5 - 2.0 (ft BLS)		01-018BH 5.0 - 6.0 (ft BLS)	
		Action Limit** (mg/kg)	01-019BH 0.5 - 2.0 (ft BLS)	01-019BH 2.0 - 3.5 (ft BLS)	01-020BH 0.5 - 2.0 (ft BLS)	01-020BH 0.5 - 1.0 (ft BLS)	01-021BH 0.5 - 2.0 (ft BLS)	01-021BH 0.5 - 1.0 (ft BLS)	01-022BH 0.5 - 2.0 (ft BLS)	01-022BH 0.5 - 2.0 (ft BLS)	01-023BH 0.5 - 2.0 (ft BLS)	01-023BH 0.5 - 2.0 (ft BLS)			
Antimony	6010	3.6U	4.8B	6.1	5.1B	4.7B	3.8U	7.5	13.8	19.3	19.3	19.3			
Arsenic	7060	13.4	14.9	12.8	32.8	33.0	0.61U	0.27B	0.24B	0.13B	0.13B	0.13B			
Beryllium	6010	0.22B	0.15B	0.88	0.21B	0.09U	0.10U	0.10U	0.10U	0.11U	0.11U	0.11U			
Cadmium	7131	0.10U	0.09U	0.24B	0.09U	0.13U	14.7	15.1	10.9	23.6	20.6	20.6			
Chromium	6010	11.4	12.6	16.7	20.0	20.0	5.2	9.3	0.12U	0.11U	19.0	19.0			
Copper	6010	18.7	20.8	38.7	20.0	0.12	0.13	10.2	0.54	0.46U	0.52U	0.52U			
Lead	7421	4.7	3.7	18.4	5.2	0.12	0.13	10.2	0.54	0.60U	0.63U	0.63U			
Mercury	7470	0.11U	0.10U	0.12	0.13	0.12	0.12	17.7	0.63	0.11U	0.11U	0.11U			
Nickel	6010	12.4	14.0	9.9	26.7	26.7	0.12	0.12	0.60U	0.60U	0.60U	0.60U			
Selenium	7740	0.49U	0.47U	0.51U	0.47U	0.54	0.54	19.0	28.3	31.3	31.3	31.3			
Silver	6010	0.57U	0.61U	0.58U	0.58U	0.56U	0.56U	19.0	28.3	31.3	31.3	31.3			
Zinc	6010	21.7	24.6	49.5	37.6	37.6	37.6	57.0	28.3	31.3	31.3	31.3			
Metals	Action Limit** (mg/kg)	01-019BH 0.5 - 2.0 (ft BLS)	01-020BH 2.0 - 3.5 (ft BLS)	01-021BH 0.5 - 2.0 (ft BLS)	01-022BH 0.5 - 2.0 (ft BLS)	01-023BH 0.5 - 2.0 (ft BLS)									
Antimony	40.0	3.8U	3.8U	5.6B	3.9U	3.7U	3.9U	3.6U	12.6	24.0	38.4	38.4			
Arsenic	30.0	42.7	50.8	58.0	59.4	0.22B	0.24B	0.24B	0.24B	0.21B	0.21B	0.21B			
Beryllium	0.8	0.24B	0.70	0.40B	0.11U	0.17B	0.12B	0.14B	0.14B	0.14B	0.14B	0.14B			
Cadmium	80.0	0.44B	0.12B	0.11U	47.5	16.5	14.6	19.2	19.2	36.1	31.8	31.8			
Chromium	2,500.0	18.2	12.0	24.9	30.9	22.7	7.2	8.0	7.2	13.3	8.0	8.0			
Copper	10,000.0	16.9	18.5	10.1	0.11U	0.11U	0.10U	0.11U	0.11U	0.11U	0.10U	0.10U			
Lead	600.0	8.9	14.1	10.1	36.4	21.1	12.6	19.3	12.6	0.45U	0.45U	0.45U			
Mercury	60.0	0.11U	0.11U	0.54U	0.51U	0.63U	0.60U	0.61U	0.50U	3.4	0.61U	0.57U			
Nickel	700.0	26.4	15.8	36.4	21.1	0.51U	0.51U	0.51U	0.50U	19.3	25.9	25.9			
Selenium	2,500.0	0.48U	0.47U	0.60U	0.63U	41.5	39.1	39.1	39.1	30.0	0.61U	0.49U			
Silver	200.0	0.60U	0.60U	0.60U	0.60U	47.2	47.2	47.2	47.2	45.0	45.0	45.0			
Zinc	2,500.0	43.3	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6			

* — Analyte concentrations expressed in milligrams per kilogram.

** - Massachusetts Contingency Plan

TPH - Total Petroleum Hydrocarbons.

ft BLS - feet below land surface.

Bold — Indicates compound detected above action limit.

U — Indicates analyte was not detected at given detection limit.

B — Reported value obtained from reading less than the contract required detection limit, but greater than or equal to the instrument detection limit.

DUP - Duplicate.

BH - Borehole.

5.4 INITIAL AND ADDENDUM SI FINDINGS

Investigative findings from the initial SI at IRP Site No. 1 indicated SVOC, TPH, and metal contamination in excess of MADEP MCP/RCs. Pyrene (an SVOC) was detected in 6 of the 24 soil samples analyzed during the initial SI. Pyrene was detected in two samples collected during the Addendum SI above AMDLs, but below MCP/RCs. Additionally, phenanthrene was detected above AMDLs but below MCP/RCs in four samples from the initial SI and in the two samples collected during the Addendum SI. All SVOCs detected above MCP/RCs are shown on Figure 5.4.

TPH were detected in 11 of the 24 soil samples analyzed during the initial SI. TPH were detected in all 14 samples from the Addendum SI. Maximum TPH concentrations at each boring location from the initial SI and the Addendum SI are shown in Figure 5.5.

Arsenic, beryllium, and lead were detected during the initial SI at concentrations in excess of MCP/RCs. During the Addendum SI, arsenic was detected in seven soil samples and beryllium was detected in one soil sample in excess of MCP/RCs. Maximum arsenic concentrations at each boring location from the initial SI and the Addendum SI are shown in Figure 5.6. Arsenic is present over the entire IRP Site No. 1 area and may represent naturally-occurring concentrations. Maximum beryllium concentrations at each boring location from the initial SI and the Addendum SI are shown in Figure 5.7. Beryllium levels above MCP/RCs are located near the eastern portion of the Site boundary. The highest levels detected at the Addendum Site (59.4 mg/kg arsenic and 0.88 mg/kg beryllium) are near the highest background concentrations obtained during the initial SI (67.0 mg/kg arsenic and 0.3 mg/kg beryllium).

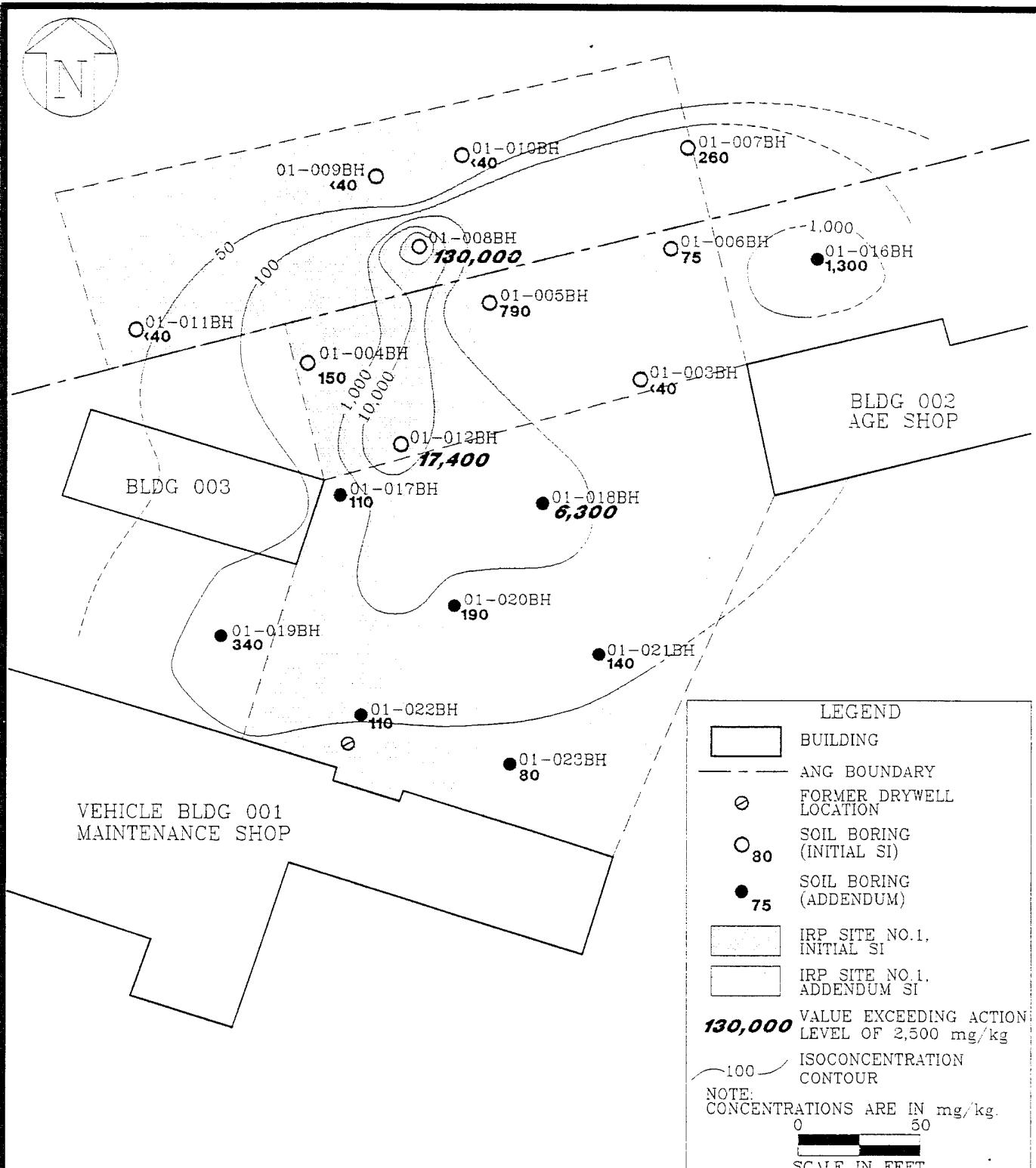
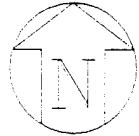
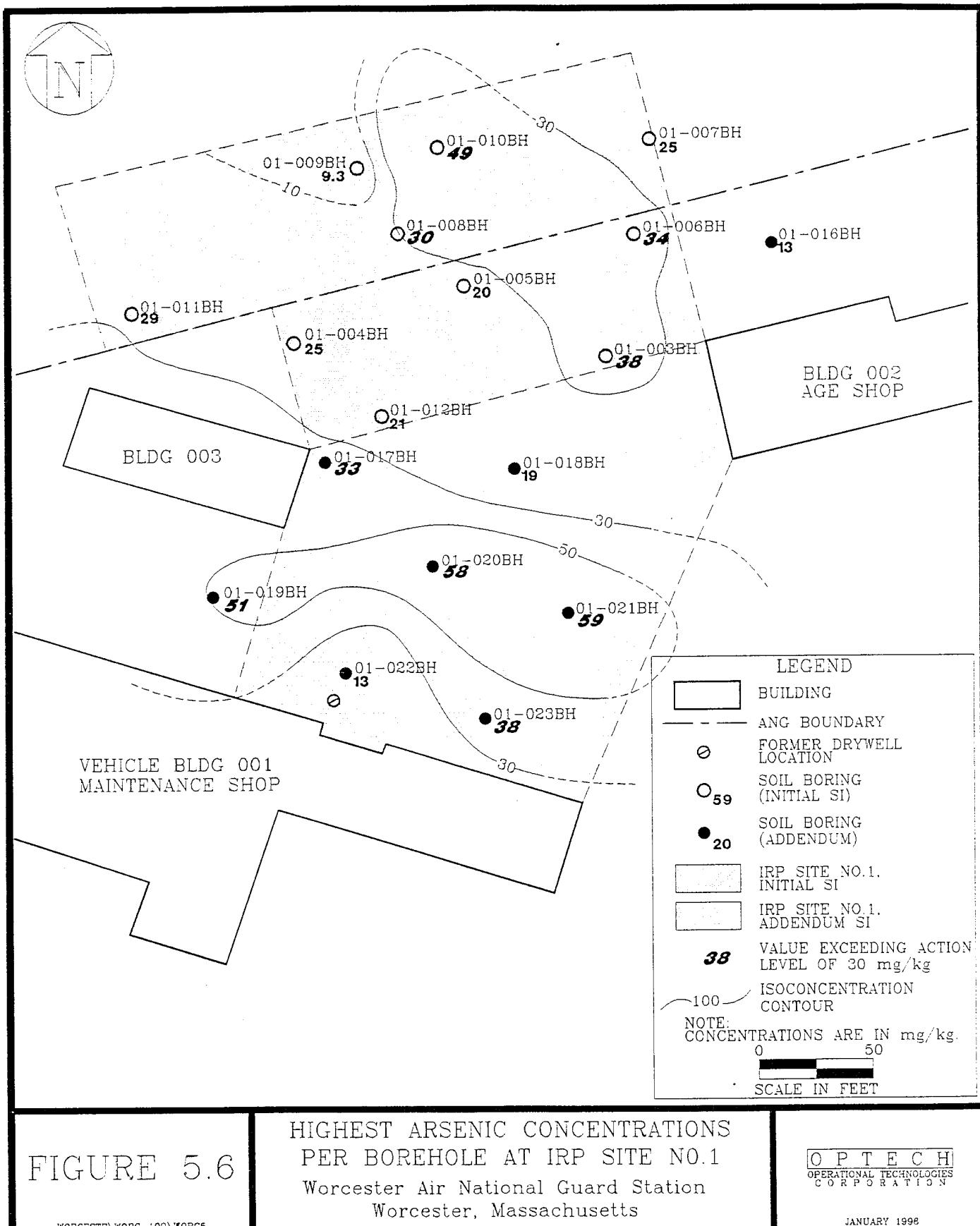


FIGURE 5.5

HIGHEST TPH CONTAMINATION
PER BOREHOLE AT IRP SITE NO.1
Worcester Air National Guard Station
Worcester, Massachusetts

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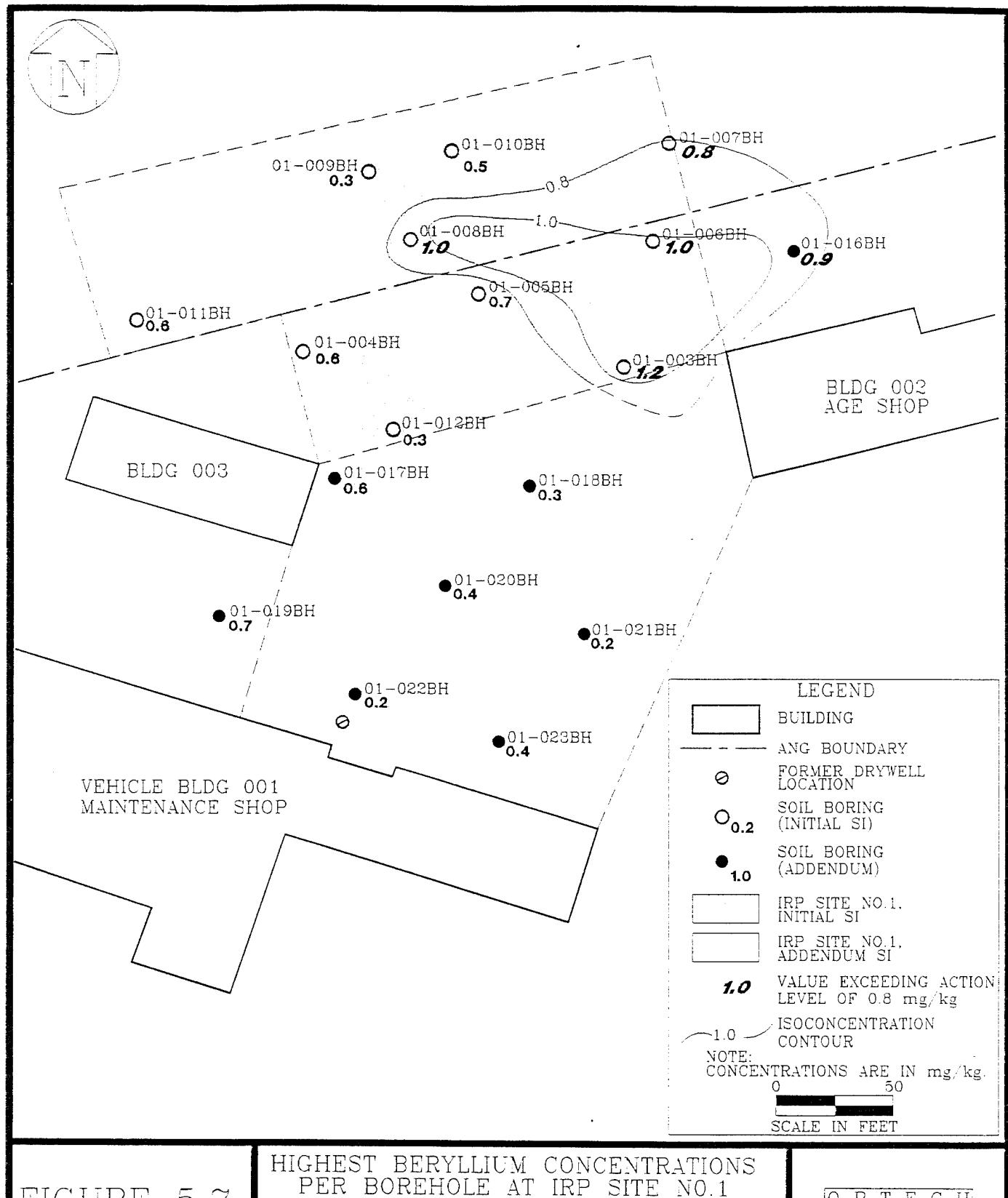


FIGURE 5.7

HIGHEST BERYLLIUM CONCENTRATIONS
PER BOREHOLE AT IRP SITE NO.1

Worcester Air National Guard Station
Worcester, Massachusetts

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SECTION 6.0 CONCLUSIONS

6.1 SUMMARY

An Addendum SI was conducted at the expanded area of IRP Site No. 1 located at the 101st ACS, Worcester ANGS, Worcester, Massachusetts. The purpose of the Addendum SI was to define the relationship between the Vehicle Maintenance Shop's former dry well and contamination detected at IRP Site No. 1 during the initial SI conducted in November 1993.

The HQ ANG/CEVR authorized OpTech to prepare an Addendum SI Work Plan and conduct the Addendum SI at the extended area of IRP Site No. 1. This investigation was conducted as outlined in the Addendum SI Work Plan submitted to the HQ ANG/CEVR in February 1995. The field investigation at the 101st ACS began on 3 April 1995 and was completed on 6 April 1995.

The field investigation at the 101st ACS was accomplished by completing the following tasks:

- Mobilizing personnel and equipment to Worcester ANGS needed to complete Addendum SI activities;
- Locating underground USTs, lines and utilities in the vicinity of drilling locations;
- Drilling 9 soil borings to obtain soil samples for laboratory analysis to determine if contamination exists at the Addendum Site, and what relationship, if any, exists between the former dry well location north of Building 001 and contamination detected during the initial SI. One soil sample was collected to assess background soil conditions;
- Collecting 15 soil samples (including analytical QA/QC and background) for analysis of VOCs, SVOCs, priority pollutant metals, TPH, and PCBs; and
- Surveying the location and elevation of all soil borings.

6.2 CONCLUSIONS

6.2.1 Soil Contamination

Fourteen soil samples (including QA/QC samples) were collected from the Addendum area of IRP Site No. 1 and submitted for laboratory analysis to confirm the presence or absence of contamination and to provide data needed to determine the relationship between a former dry well located north of Building 001 and contamination detected during the initial SI. Results from the initial SI at IRP Site No. 1 indicated a possible source of contamination north of the initial IRP Site No. 1 boundary. The discovery of floor drains in the vehicle maintenance shop draining into a dry well indicated a possible source of contamination north of the site. Potential contaminants from the dry well consist of waste oil, organic solvents, and fuels. Therefore, samples were submitted for analysis of VOCs, SVOCs, and TPH. To remain consistent with the analytical program during the initial SI, and to satisfy MADEP requirements, samples were also analyzed for PCBs and priority pollutant metals. Only those parameters, reported at greater than the sample quantification limit, exceeding background and/or MCP/RCs (MADEP ARARs), are addressed in this section.

As outlined in the *1995 SI Report* – Appendix G, soils at the Station have been classified as category S-2 according to 310 Commonwealth of Massachusetts Regulation (CMR) 40.0933(6)(a), which establishes that: "soils shall be classified as category S-2 if children are not present at the disposal site and either (but not both) the adults' frequency or intensity of use is considered to be high, pursuant to 310 CMR 40.0933(4)(b) and (c)." Table 3 of 310 CMR 40.0975(6)(b) establishes reportable concentrations for contaminants in soil based on both soil category S-2 standards and a groundwater classification. For the purpose of this investigation, groundwater at the Station has been classified as GW-1. A groundwater investigation was not within the scope of this SI; therefore, GW-1 was used because it provided the most stringent reportable cleanup standards. These classifications were used to determine MCP/RCs listed in Table 6.1.

None of the reported laboratory results for the 14 soil samples submitted for VOC or PCB analysis exceeded MCP/RCs. Two of the fourteen soil samples submitted for SVOC analysis exceeded MCP/RCs, as summarized in Table 6.1. Benzo(a)anthracene was detected at boring 01-018BH (0.5 - 2.0) at concentrations of 4,500 µg/kg, and at boring 01-019BH (2.0 - 3.5) at concentrations of 3,800 µg/kg. Benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene were also detected at boring 01-019BH (2.0 - 3.5) at concentrations of 4,200 µg/kg, 3,000 µg/kg, and 3,900 µg/kg, respectively. Only one of the 15 soil samples

submitted for TPH analysis exceeded MCP/RCs, as shown in Table 6.1. TPH were detected at boring 01-018BH (5.0 - 6.0) at a concentration of 6,300 mg/kg.

Table 6.1
Summary of Analytes Exceeding Reportable Concentrations in Soil Samples
101st ACS, Worcester ANGS, Worcester, Massachusetts

Analyte	Borehole	Depth (ft BLS)	Concentration	Massachusetts State Reportable Concentrations ^a
SVOCs				
Benzo(a)anthracene	01-018BH	0.5-2.0	4,500 µg/kg	700 µg/kg
	01-019BH	2.0-3.5	3,800 µg/kg	700 µg/kg
Benzo(b)fluoranthene	01-019BH	2.0-3.5	4,200 µg/kg	1,000 µg/kg
Benzo(k)fluoranthene	01-019BH	2.0-3.5	3,000 µg/kg	700 µg/kg
Benzo(a)pyrene	01-019BH	2.0-3.5	3,900 µg/kg	700 µg/kg
TPH	01-018BH	5.0-6.0	6,300 mg/kg	2,500 mg/kg
Metals				
Arsenic	01-017BH	0.5-2.0	32.8 mg/kg	30 mg/kg
	01-017BH	5.0-7.0	33.0 mg/kg	30 mg/kg
	01-019BH	0.5-2.0	42.7 mg/kg	30 mg/kg
	01-019BH	2.0-3.5	50.8 mg/kg	30 mg/kg
	01-020BH	0.5-2.0	58.0 mg/kg	30 mg/kg
	01-021BH	0.5-1.0	59.4 mg/kg	30 mg/kg
	01-023BH	0.5-2.0	38.4 mg/kg	30 mg/kg
Beryllium	01-016BH	7.5-9.0	0.88 mg/kg	0.8 mg/kg

^aSource: The Massachusetts Contingency Plan 310 CMR 40.0975.

ft BLS – feet below land surface.

SVOCs – Semivolatile Organic Compounds.

TPH – Total Petroleum Hydrocarbons.

BH – Borehole.

µg/kg – micrograms per kilogram.

mg/kg – milligrams per kilogram.

Dup – Duplicate.

Fourteen soil samples were submitted for priority pollutant metals analysis. Eight samples contained only one target metal at concentrations exceeding MCP/RCs as summarized in Table 6.1. Arsenic in seven samples and beryllium in one sample were detected at concentrations exceeding MCP/RCs of 30 mg/kg and 0.8 mg/kg, respectively. Arsenic concentrations exceeding MCP/RCs ranged from 32.8 to 59.4 mg/kg. Arsenic was detected in background borings 01-001BH and 01-002BH (initial SI) at 36 and 67 mg/kg, respectively, and from 01-024BH (Addendum SI) at 9.3 mg/kg. Beryllium was detected in excess of MCP/RCs in 01-016BH (7.5 - 9.0) at 0.88 mg/kg. Beryllium was detected in background borings 01-001BH and 01-002BH (initial SI) at 0.2 and 0.3 mg/kg, respectively, and from 01-024BH (Addendum SI) at 0.5 mg/kg.

Analytical results from the initial and Addendum SI indicate the probable sources of SVOC and TPH contamination at IRP Site No. 1 are the former USTs 1-1, 1-3, 2-1, 2-2, 3-1, and 3-2. (Figure 2.3), and the associated subsurface piping system. The former UST locations are shown on Figure 2.3. The remaining USTs and associated piping are currently in use at the Station. Arsenic and beryllium detected at the site reflect elevated levels of naturally-occurring concentrations as indicated by background samples.

6.2.2 Relationship Between Contamination at IRP Site No. 1 and the Former Dry Well Location North of Building 001

Based on results obtained from the Addendum SI, no relationship can be established between the former dry well (tank #1-4, Figure 2.3) and contamination detected during the SI at IRP Site No. 1. SVOCs and TPH discussed in Section 5.4 do not indicate the former dry well location as a source of contamination as seen in borings 01-003BH, 01-005BH, 01-012BH, 01-018BH, and 01-019BH.

SECTION 7.0 RECOMMENDATIONS

Based on the results of the Addendum SI, no further investigative action is recommended under the IRP. The following recommendation is presented:

- Further investigate the area surrounding the active USTs as part of the RCRA Subtitle I and Massachusetts UST compliance programs.

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